Suisun Marsh Charter Modeling Update and Review

Chris Enright
Kate Le
Xiao Wang
Victor Pacheco

DWR

April 13, 2006

Outline

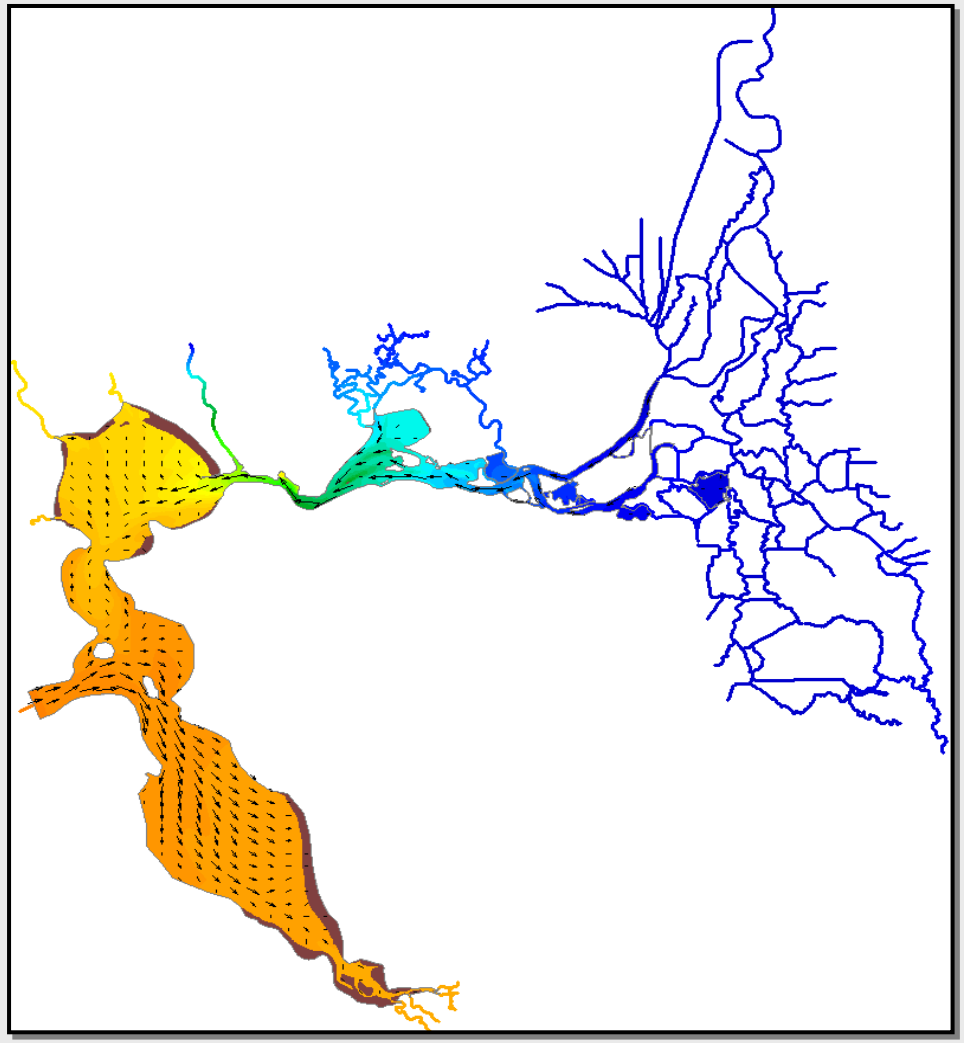
1. How we use hydrodynamics/transport models
2. Modeling tools: DSM2 and RMA
3. 1995 WQCP modeling review
4. CALFED Suisun Marsh Levee Investigation modeling review
5. Writing Group modeling review
6. Summary of salinity modeling results

1. How we use hydrodynamics/transport models

- “All models are wrong, some are useful.”

Modelers must:

- Understand nut/bolts
- Be detail oriented
- Be skeptical
- Be transparent about model capability
- Proceed boldly



1. How we use hydrodynamics/transport models

- Questions drive everything
- Parsimony of time/space scales and data

Examples:

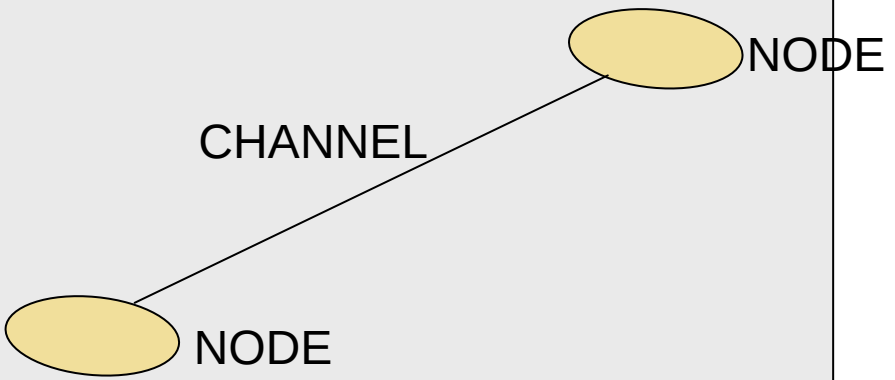
- Will we meet standards? (course time/space, 1D)
- SMSCG operation effects? (semi-course time/space, 1D)
- What is the frequency and magnitude of tidal inundation at potential restoration sites? (fine, 2D)
- Will sediment accrete on a particular site? (fine time/space scale, 2D/3D model)

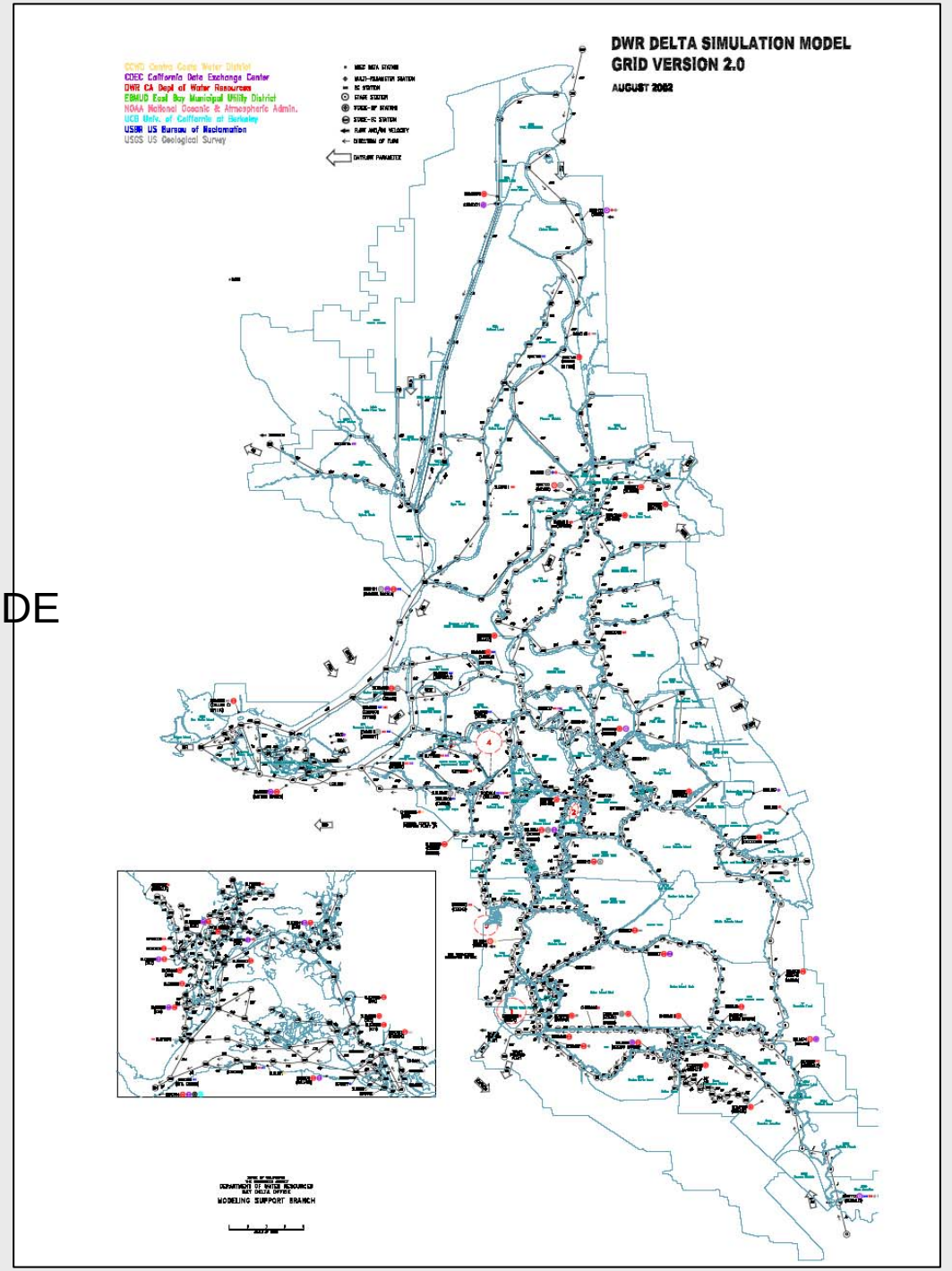
2. Modeling tools

- DSM2 (1D finite difference model)
- RMA (1-2-3D finite element model)

DSM2 model

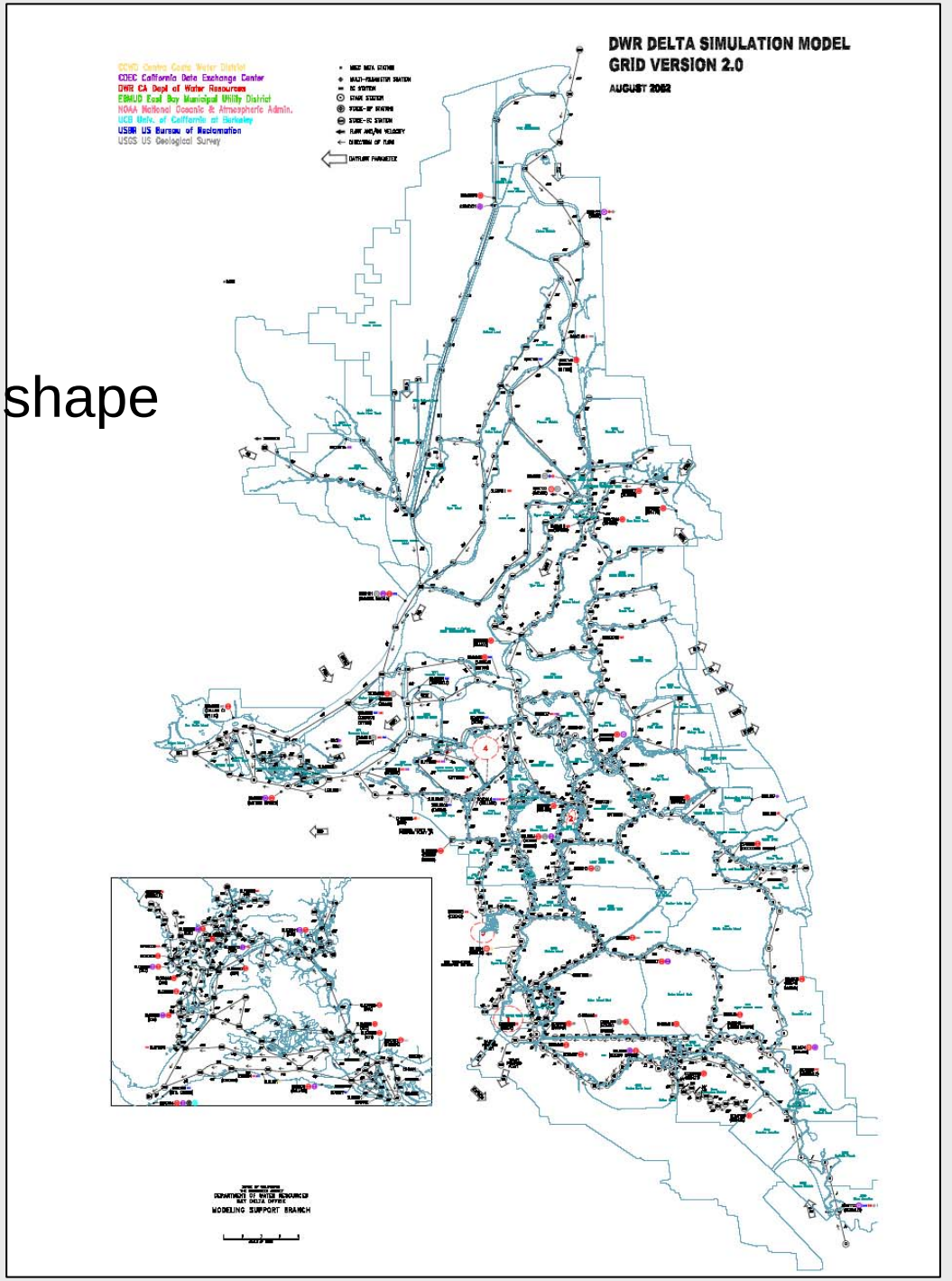
- ~ 500 channels
- ~ 400 nodes





DSM2 model

- ~ 500 channels
- ~ 400 nodes
- Channels have rectangular shape



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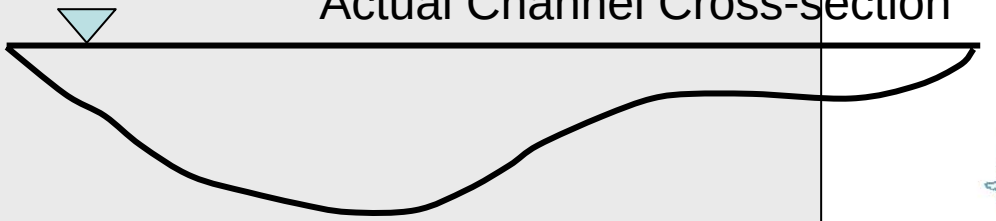

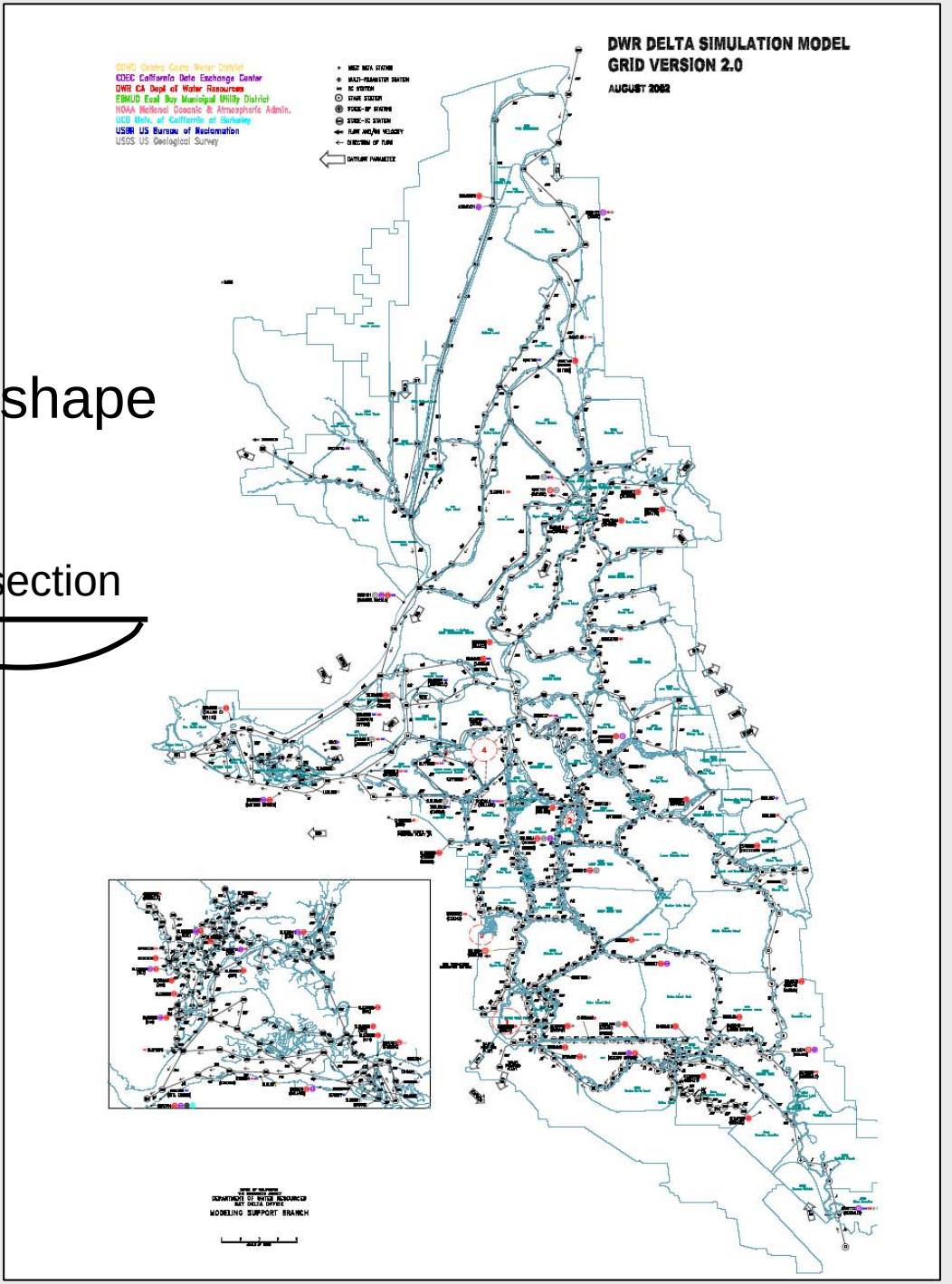

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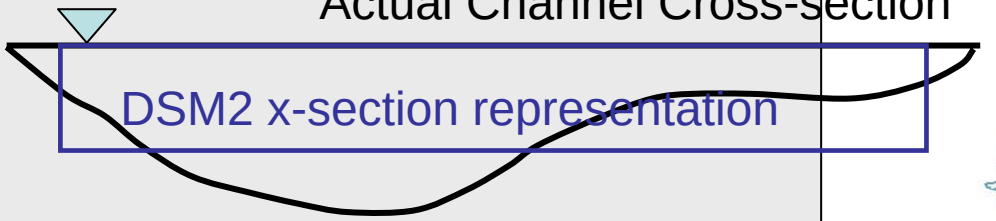

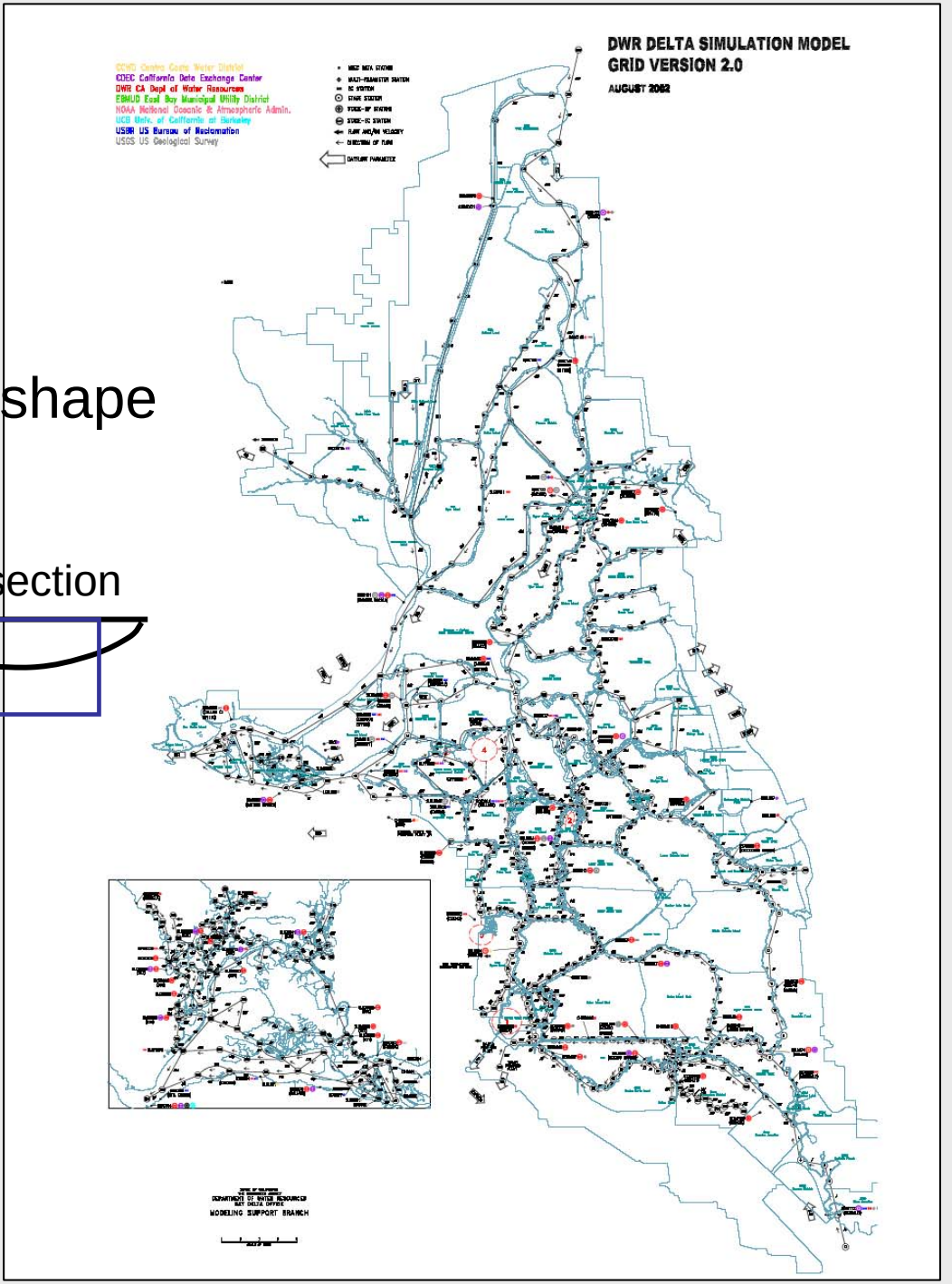

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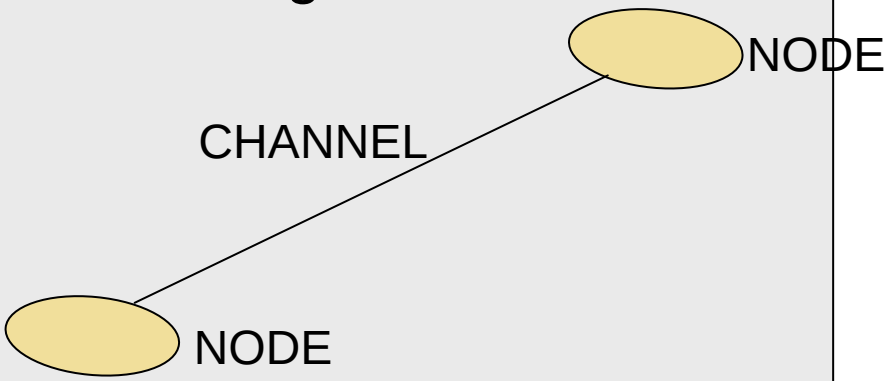

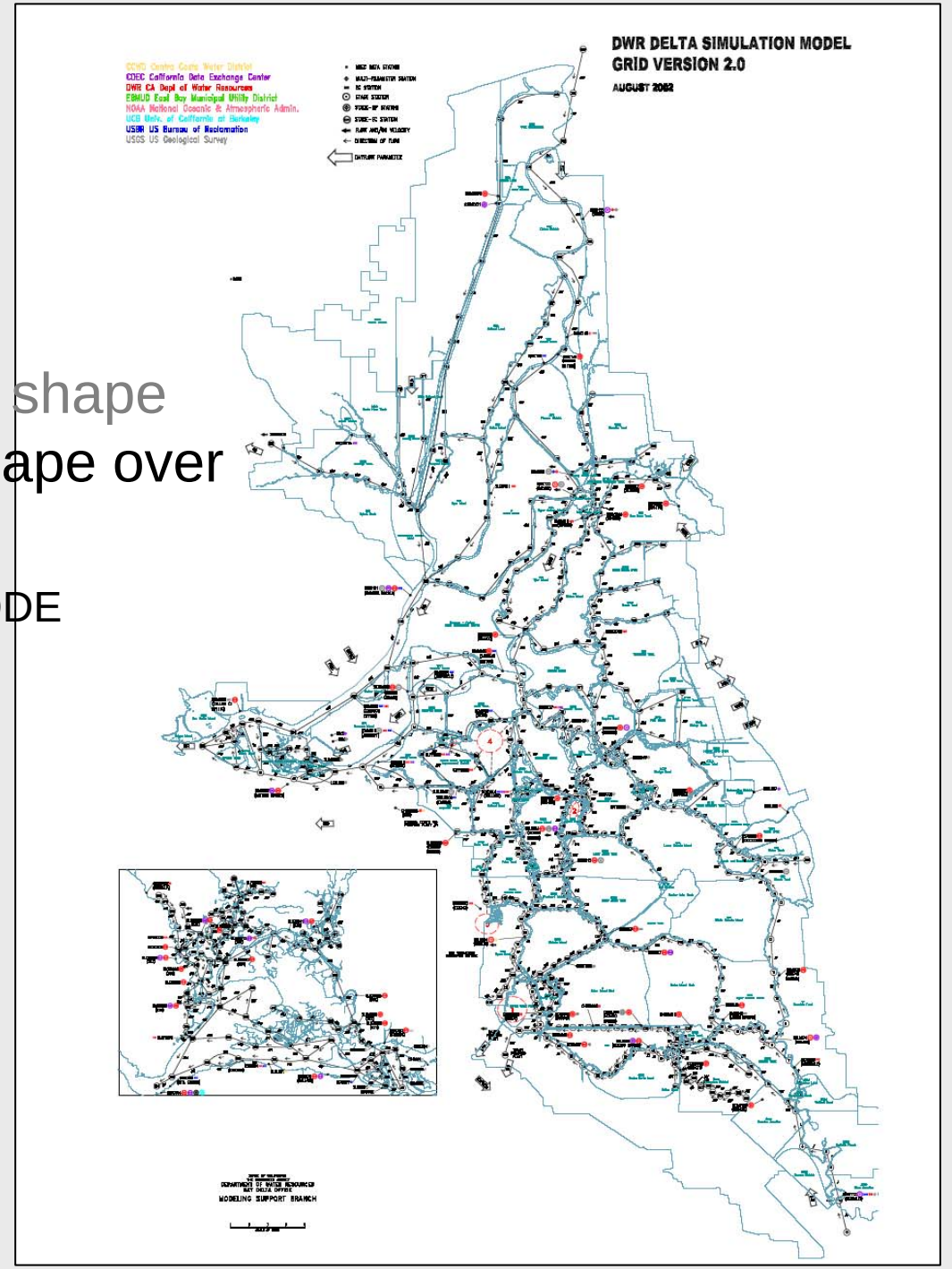

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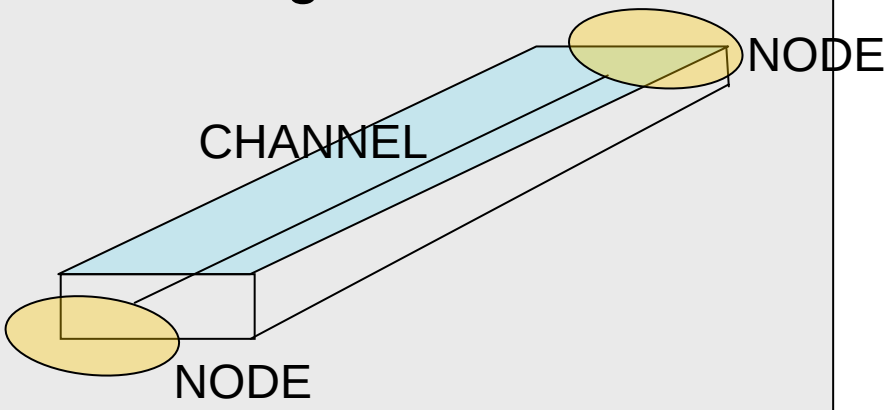
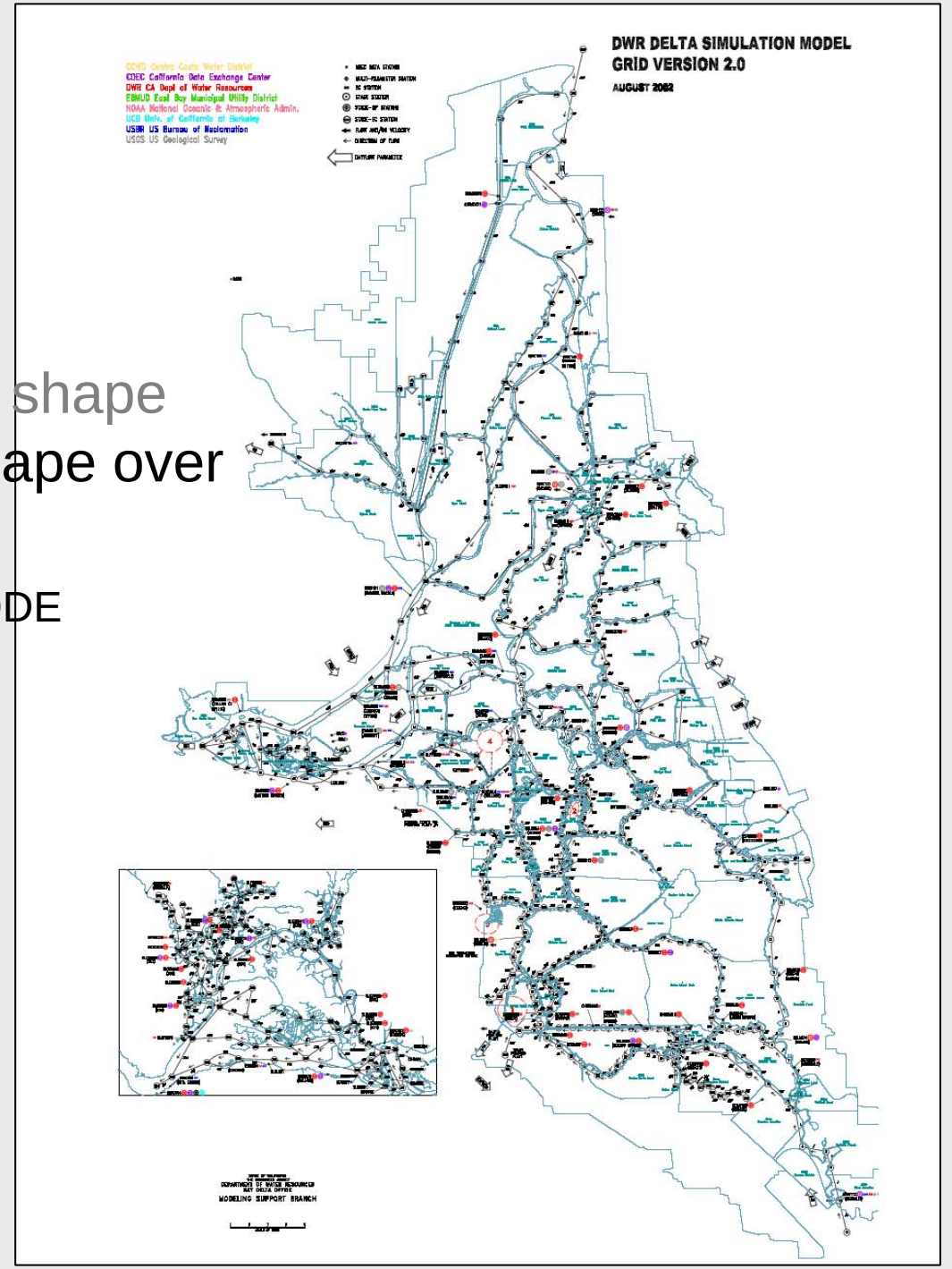
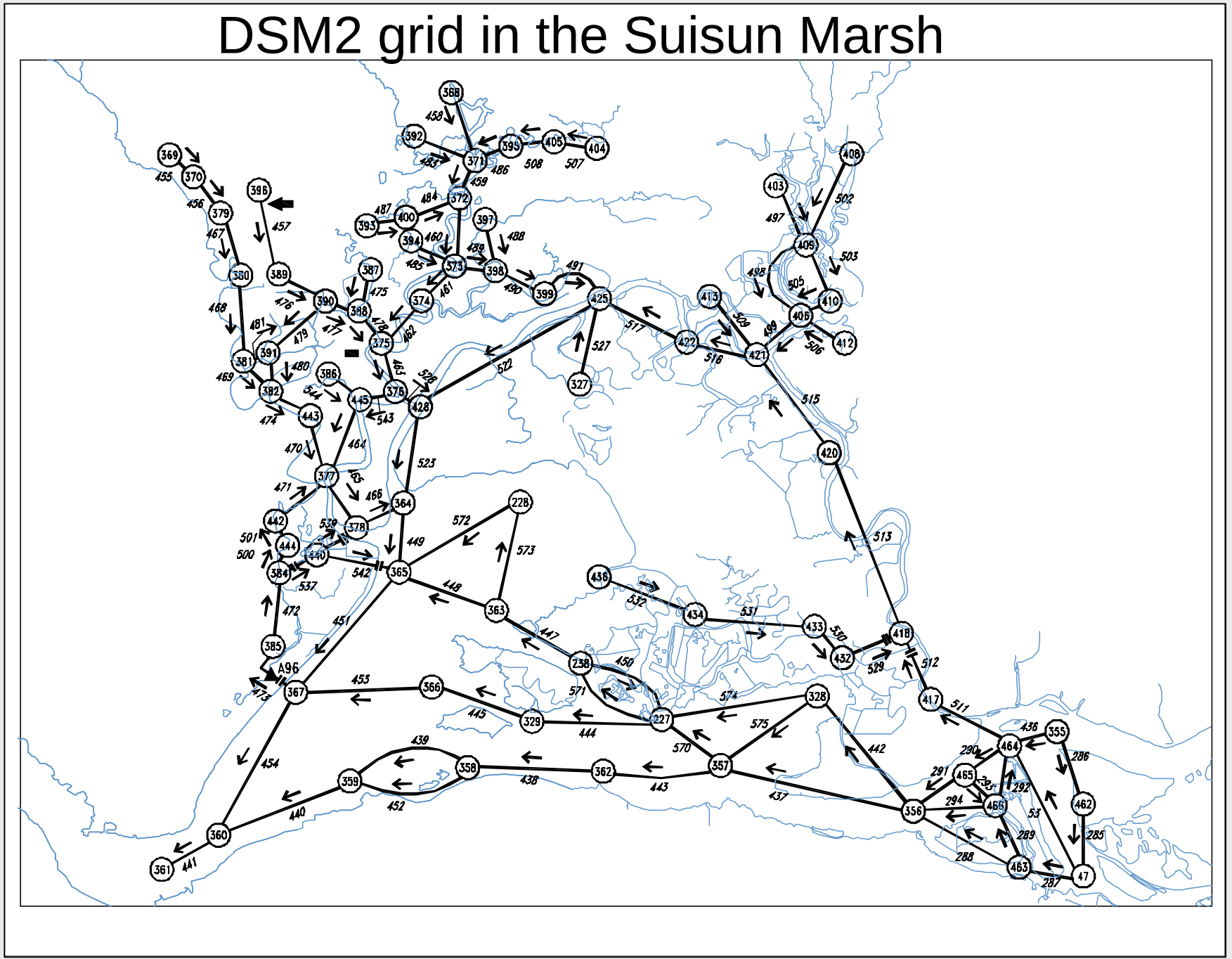


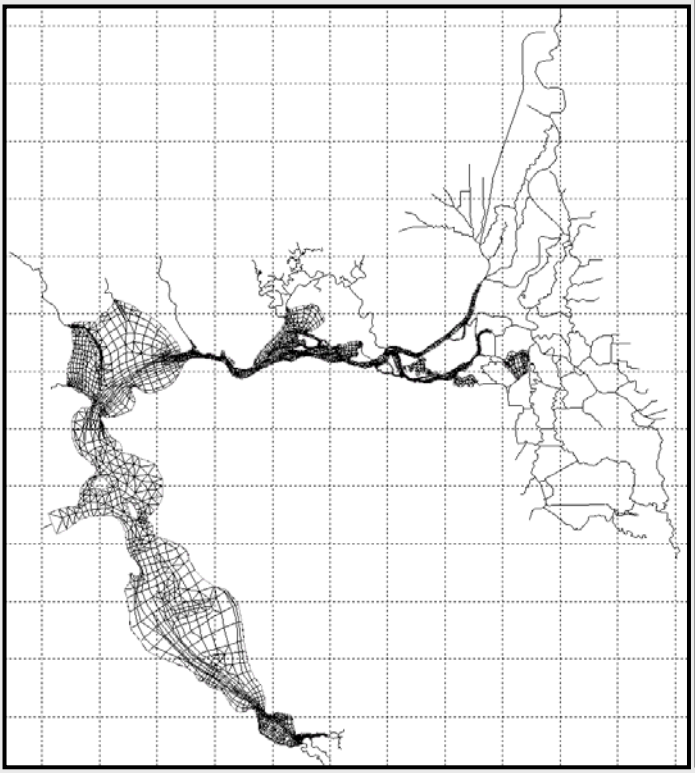


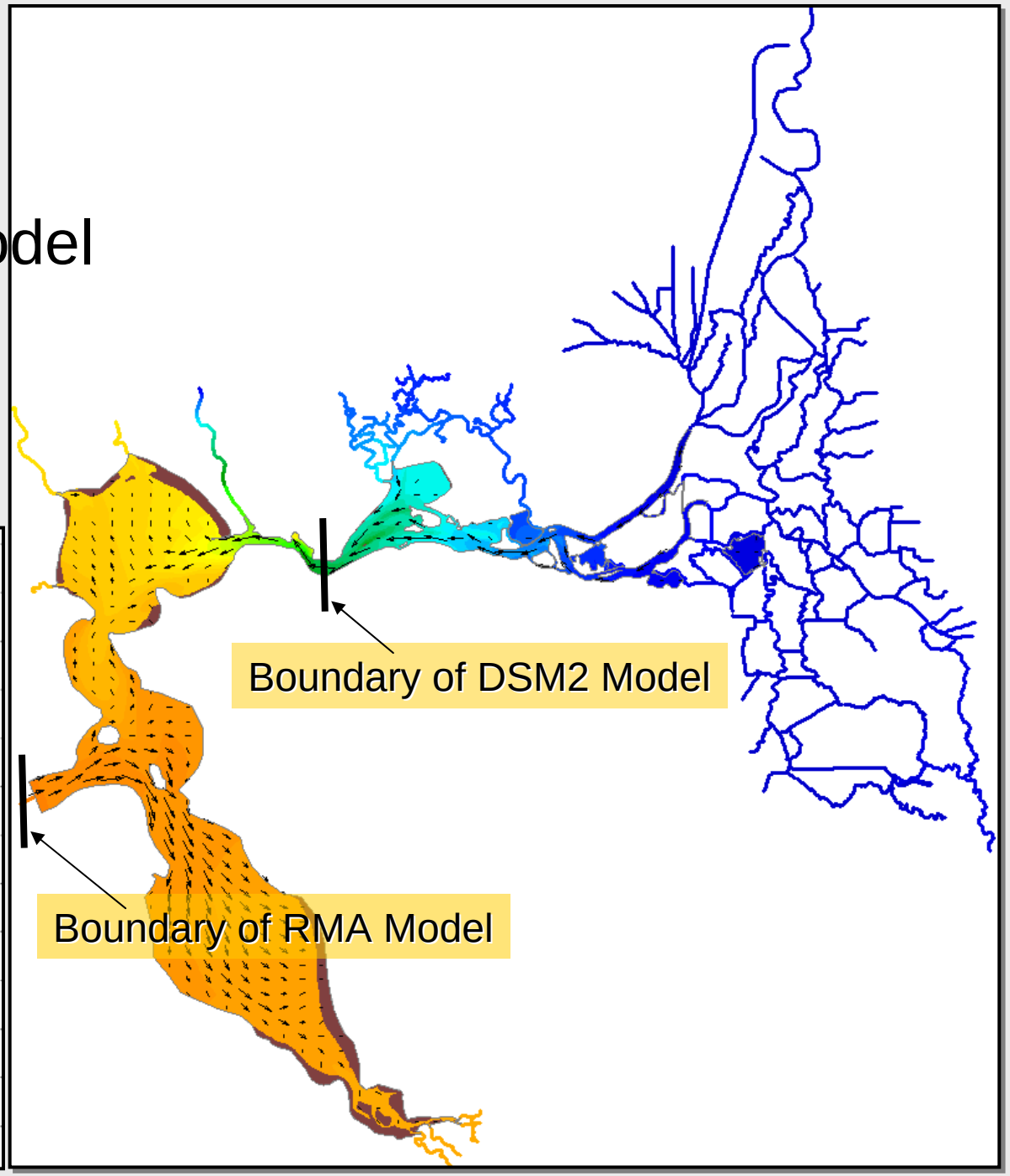
DSM2 grid in the Suisun Marsh



RMA Model

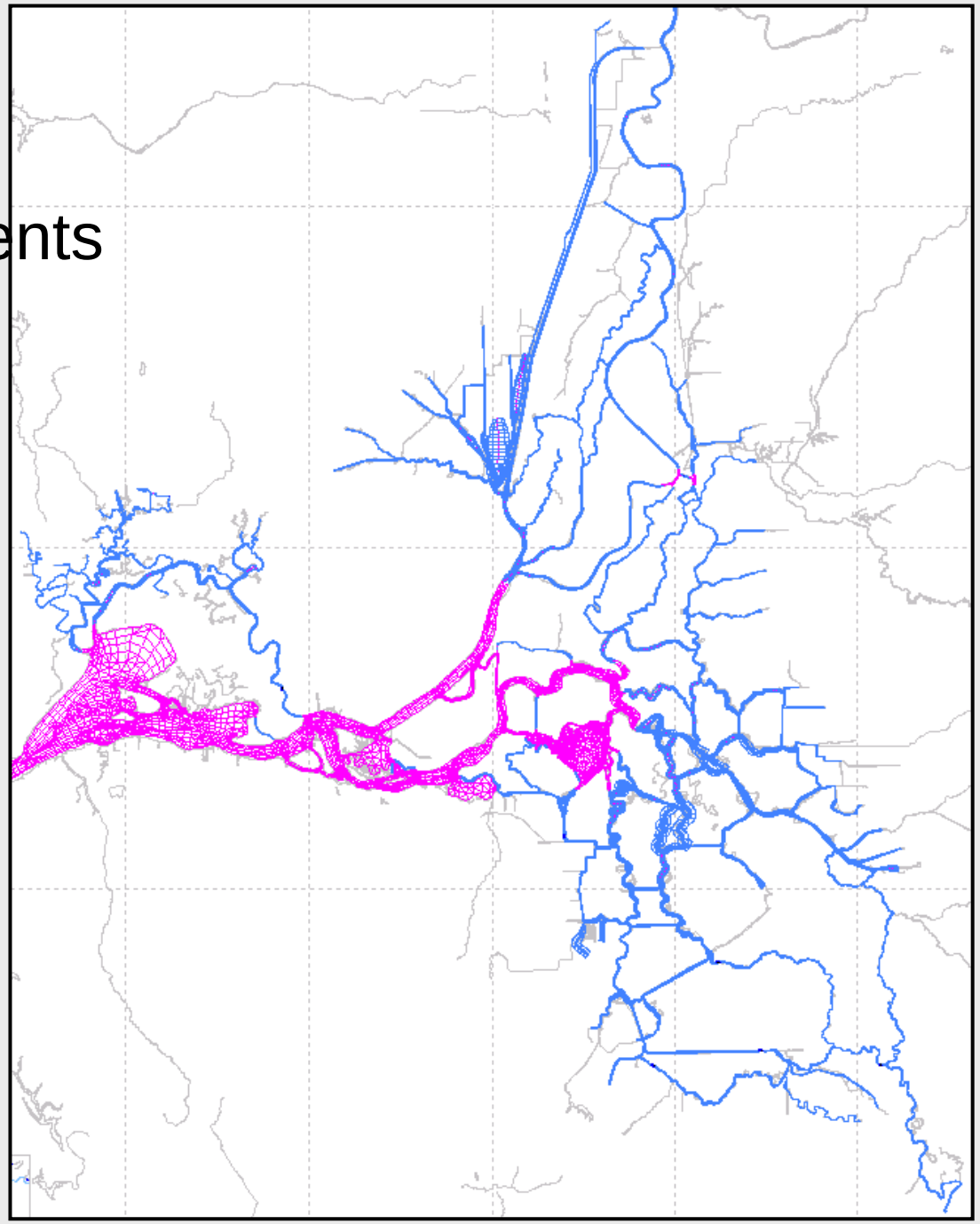
- Full Bay/Delta Model





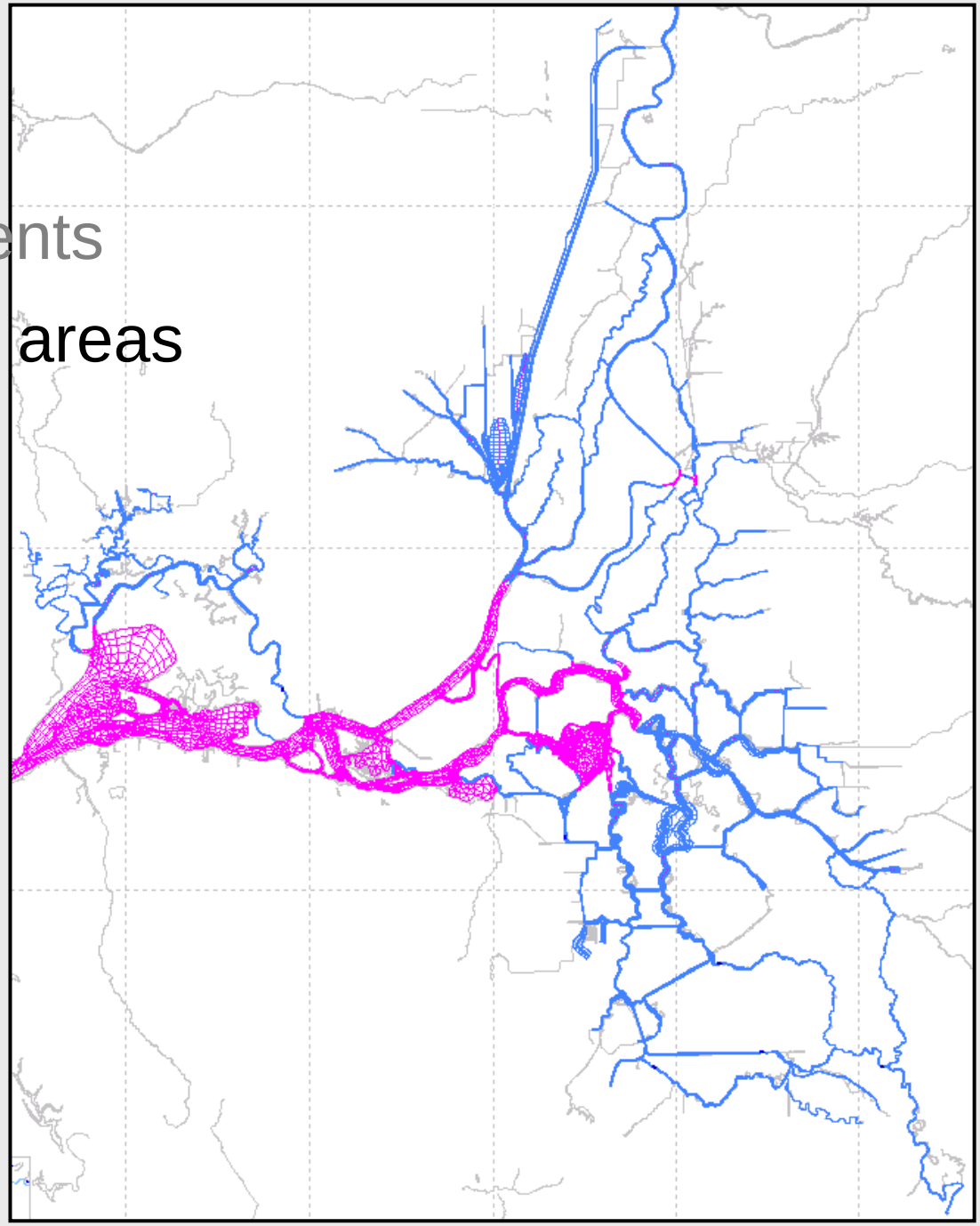
RMA Model

- > 25,000 finite elements



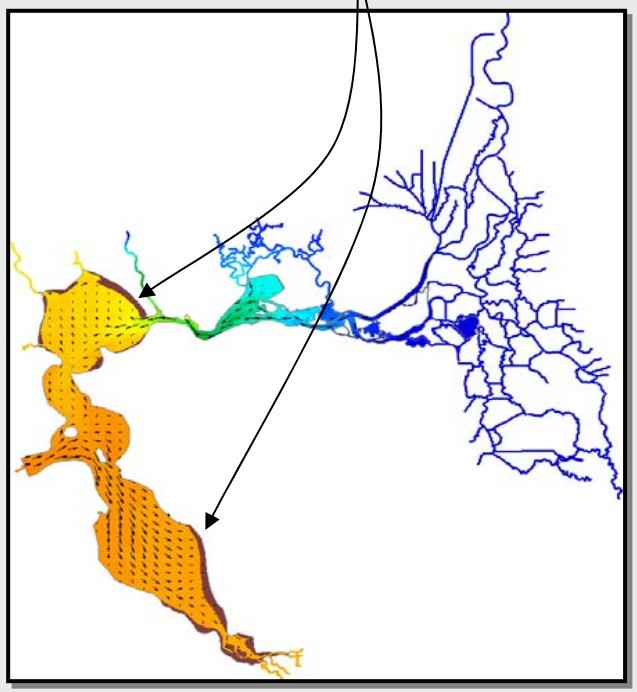
RMA Model

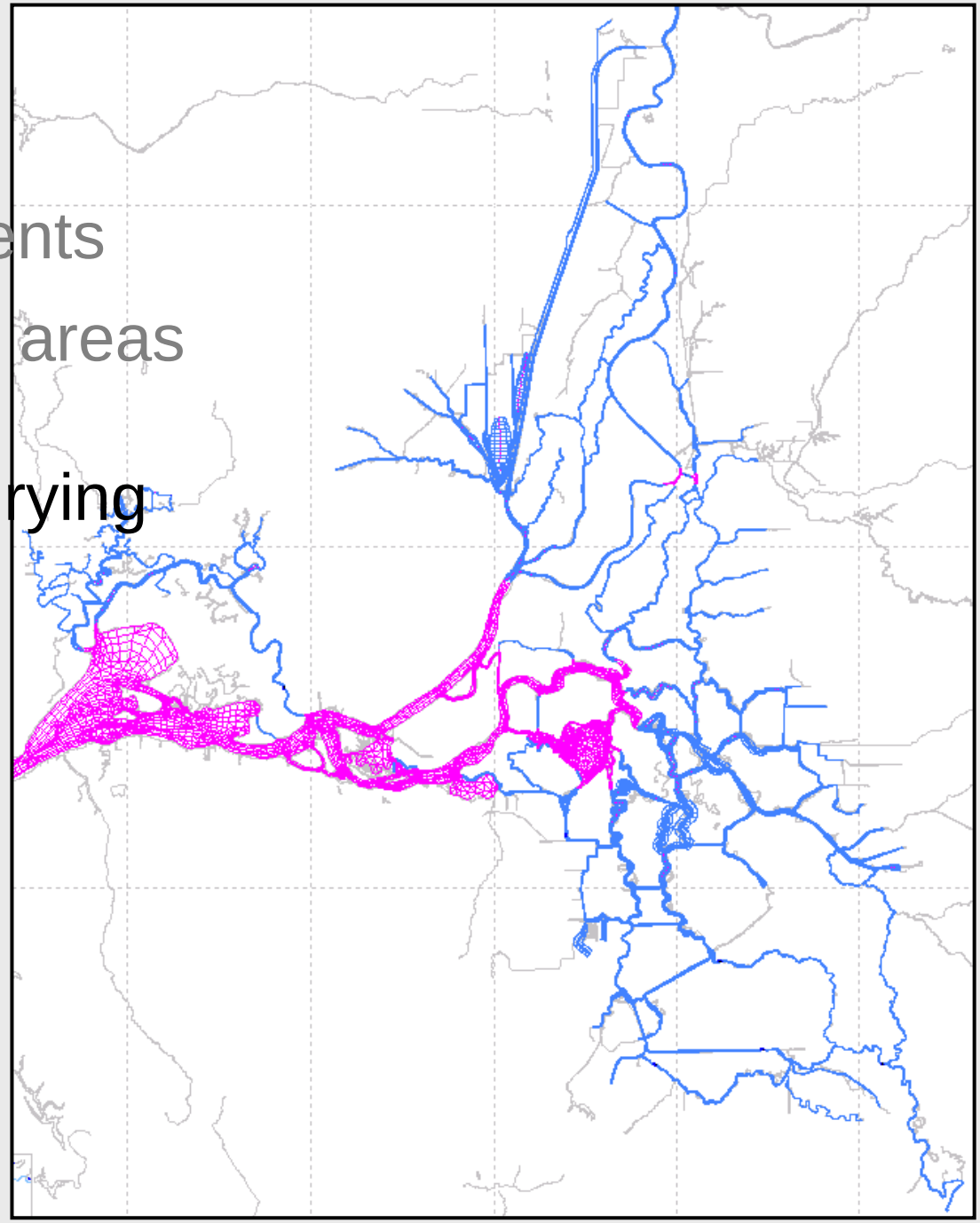
- > 25,000 finite elements
- Handles high friction areas (like fringe marsh.)



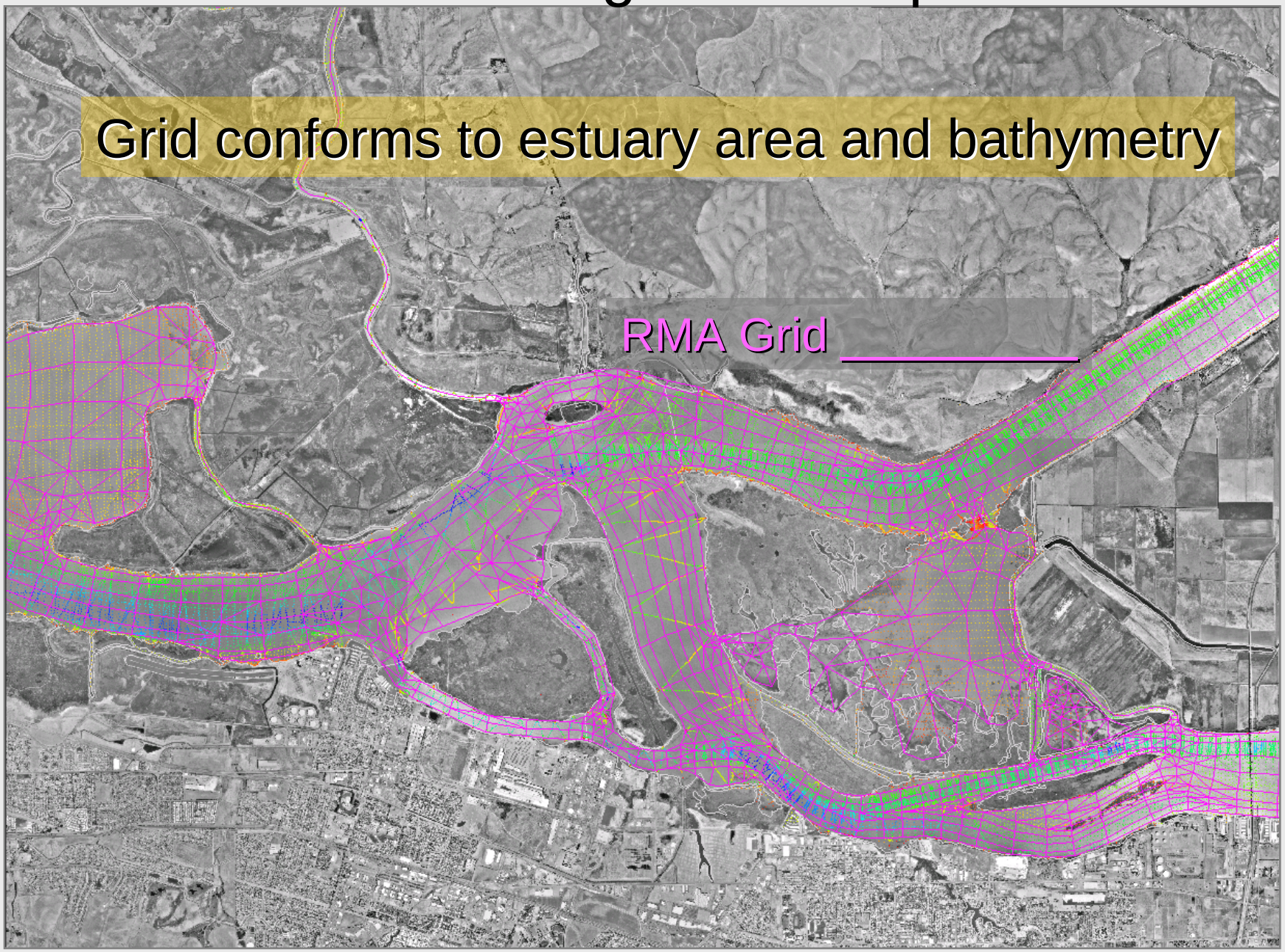
RMA Model

- > 25,000 finite elements
- Handles high friction areas (like fringe marsh.)
- Allows wetting and drying elements

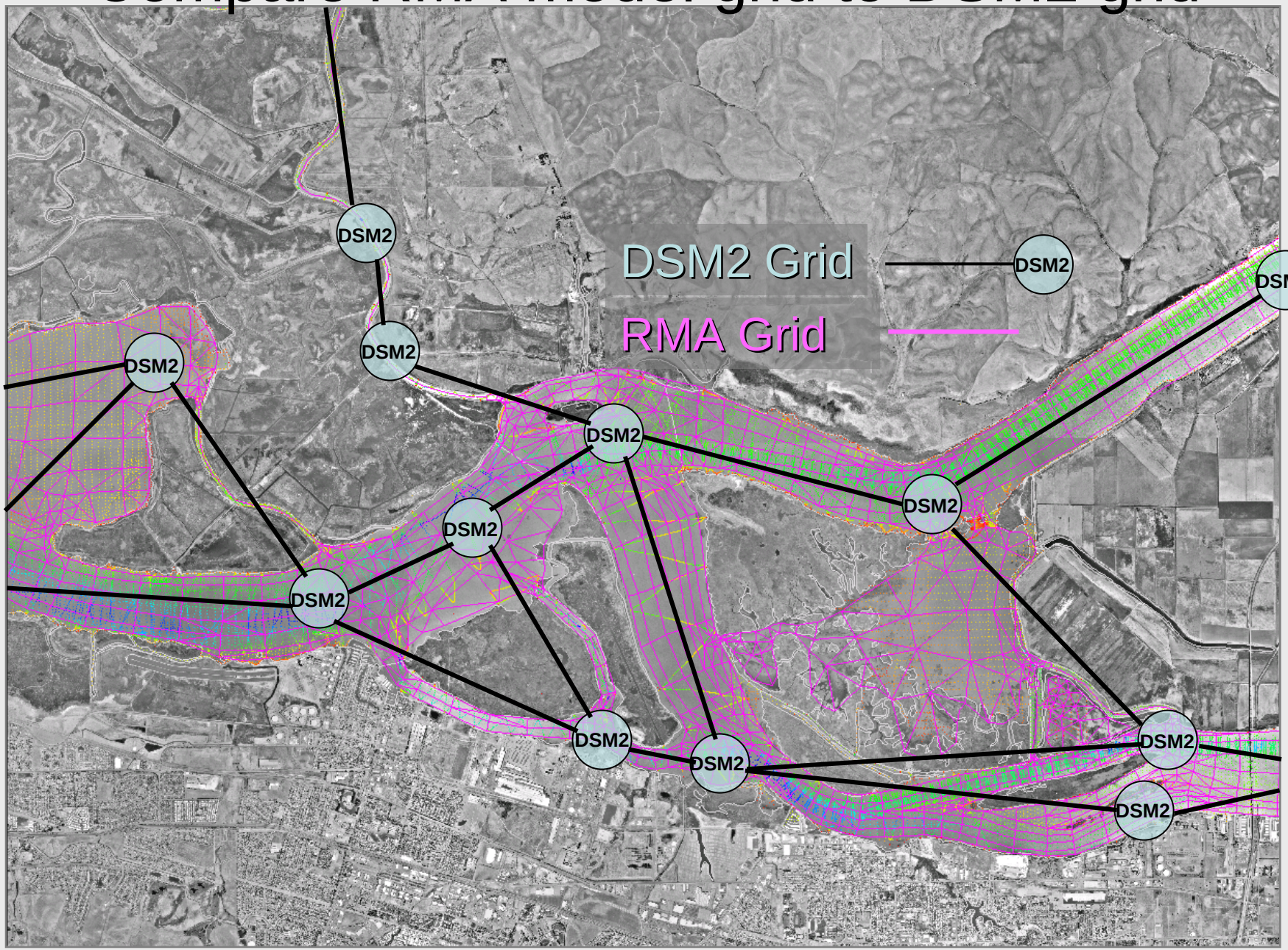




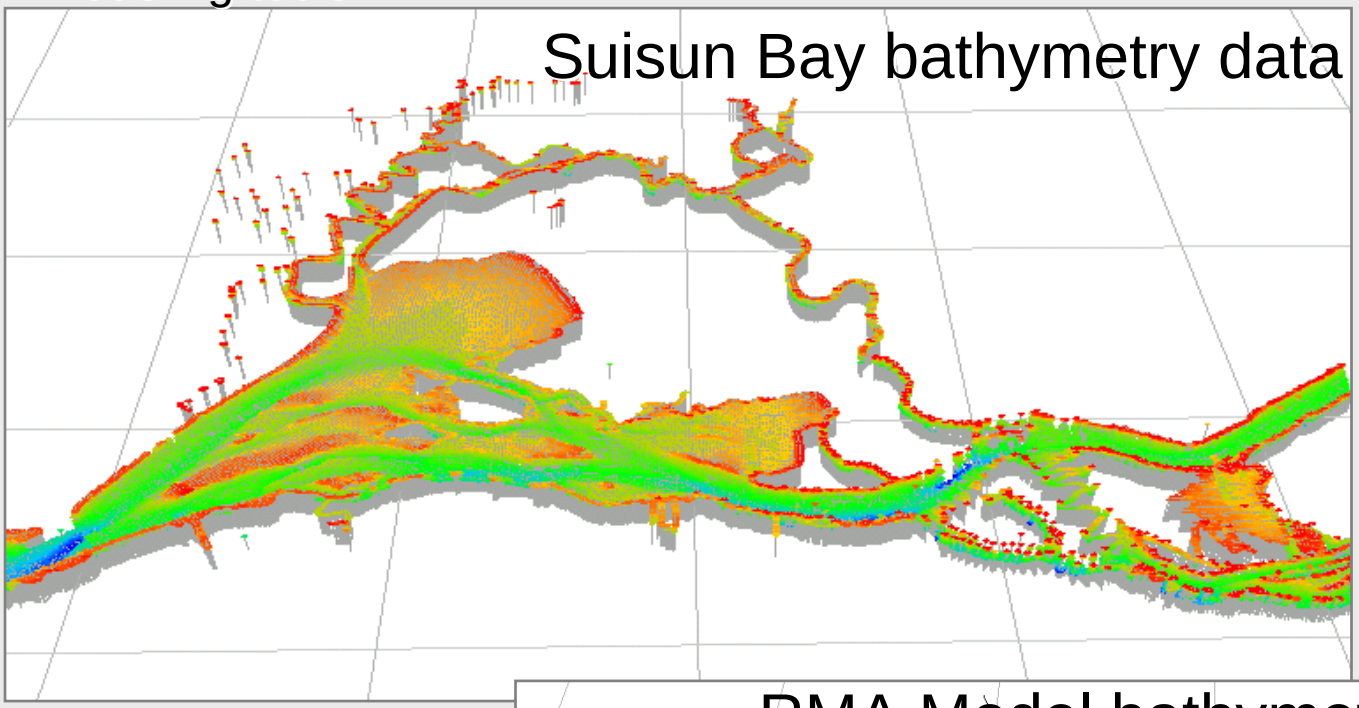
RMA model grid development

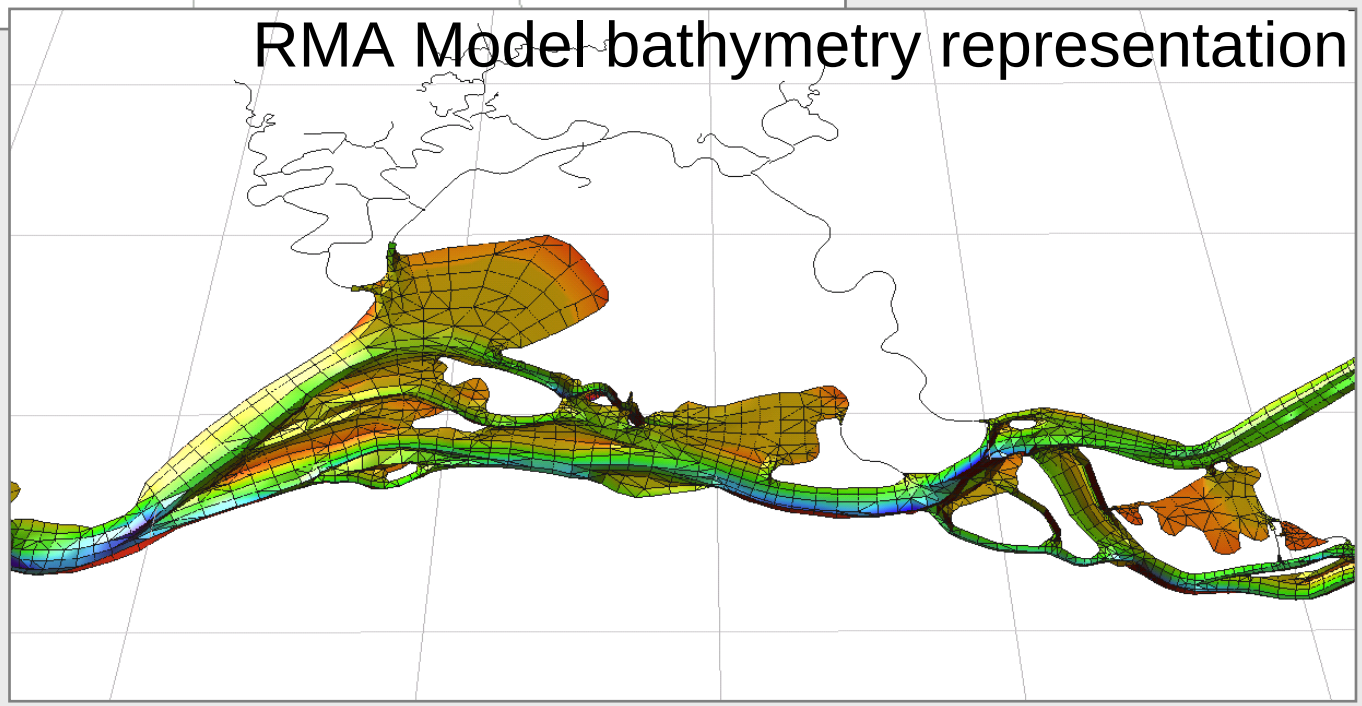


Compare RMA model grid to DSM2 grid

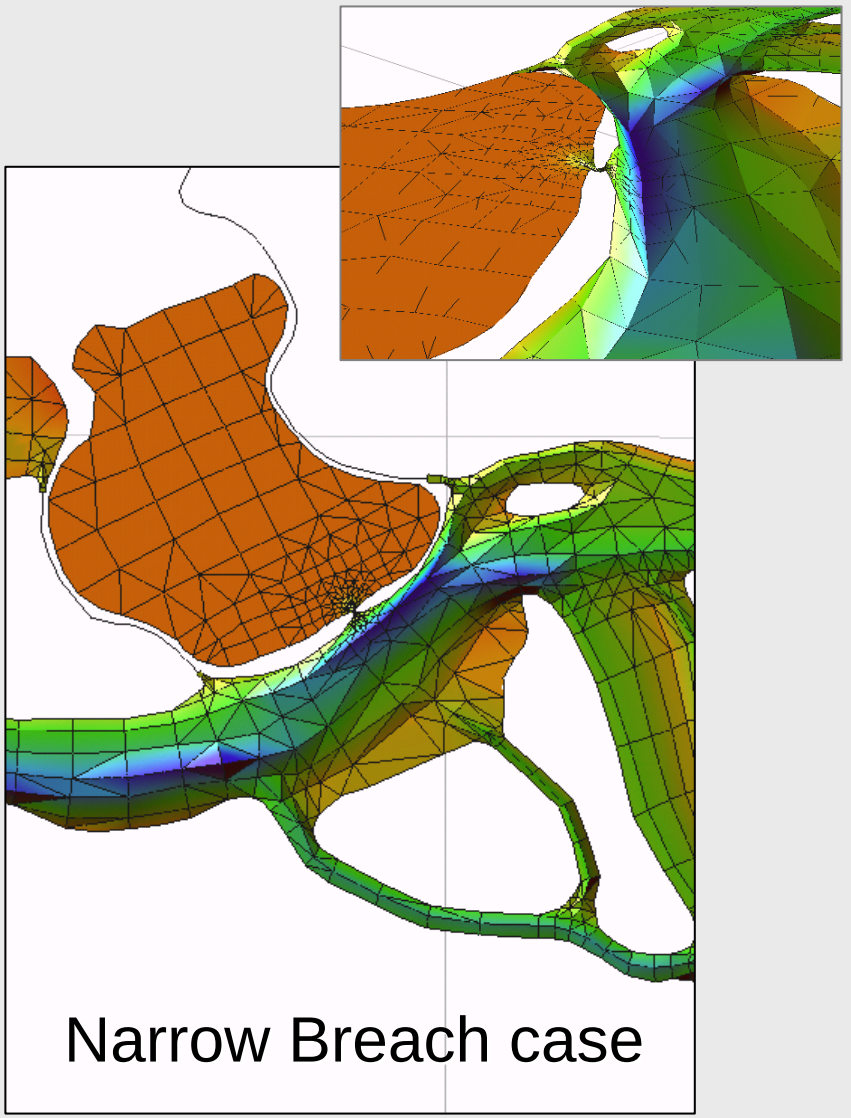


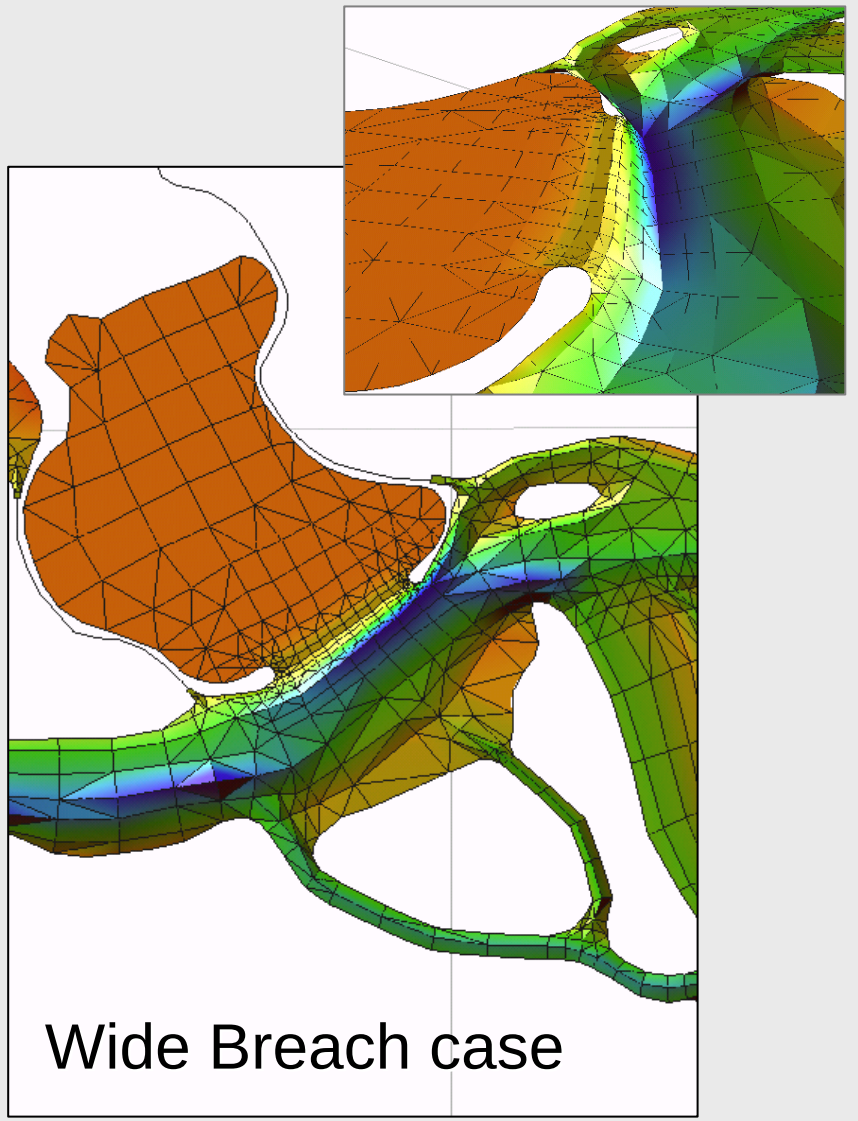
2. Modeling tools



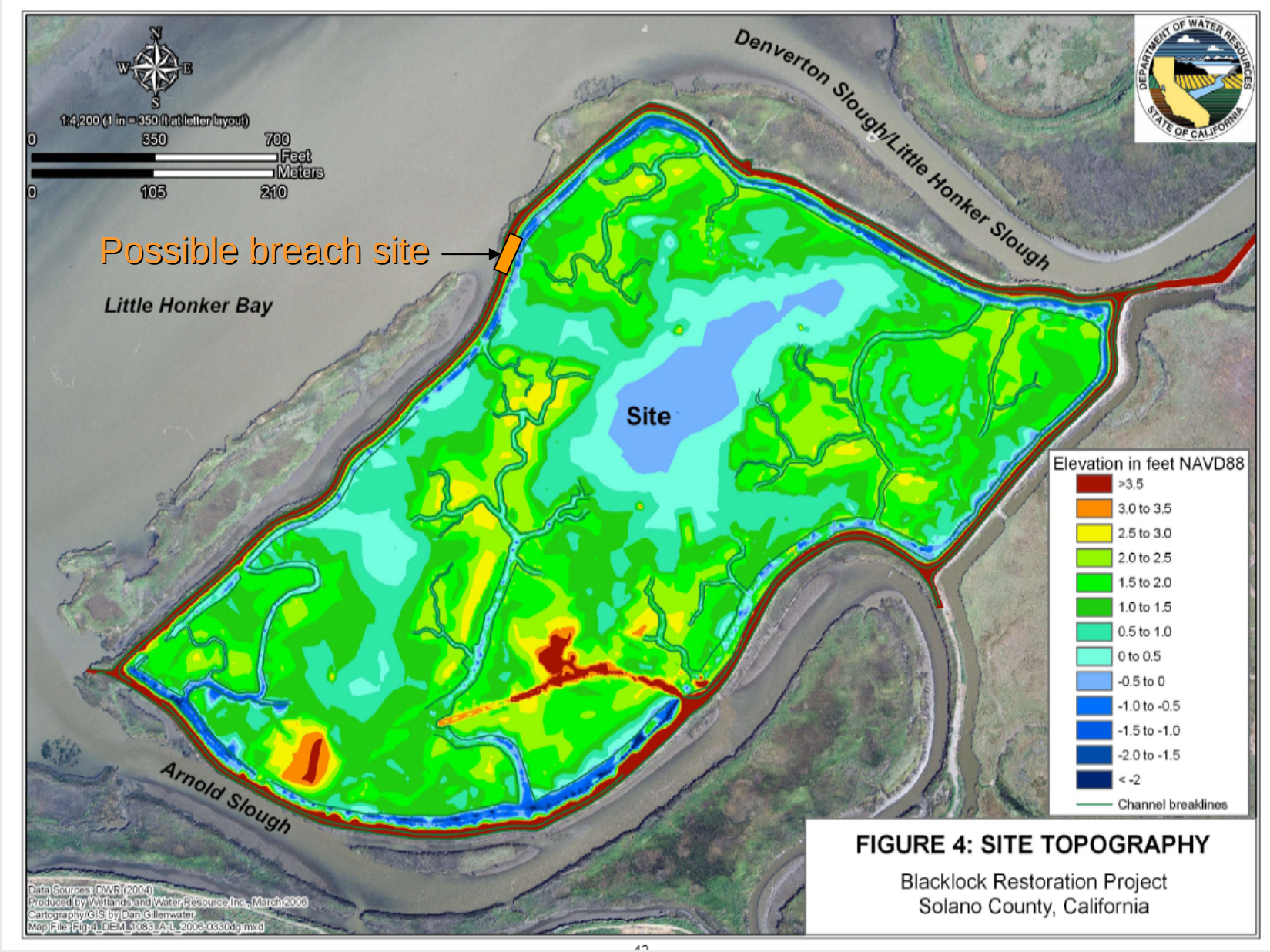


Van Sickle Island Levee Breach Configurations





How each model handles Blacklock



DSM2 Representation of Blacklock

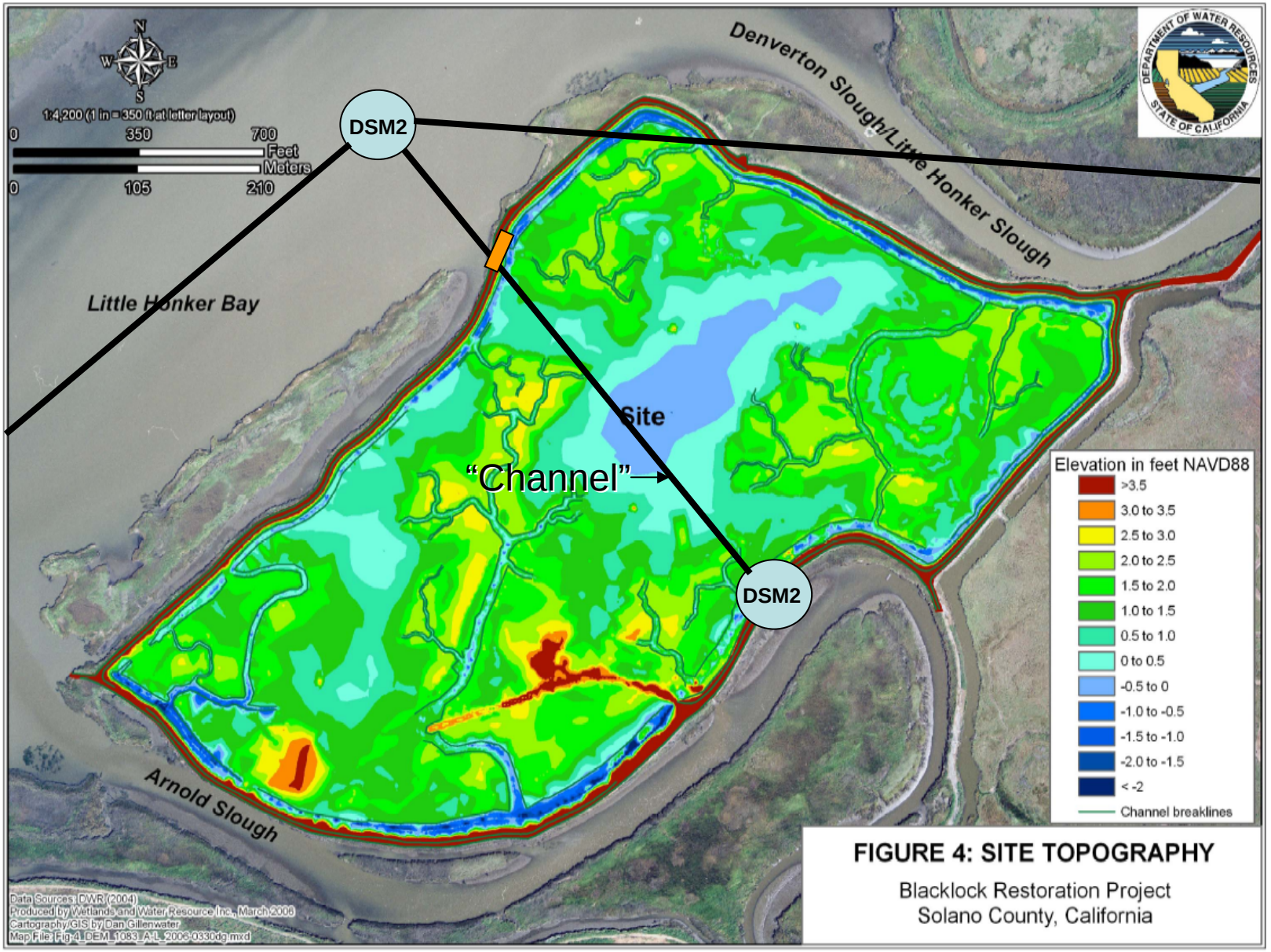
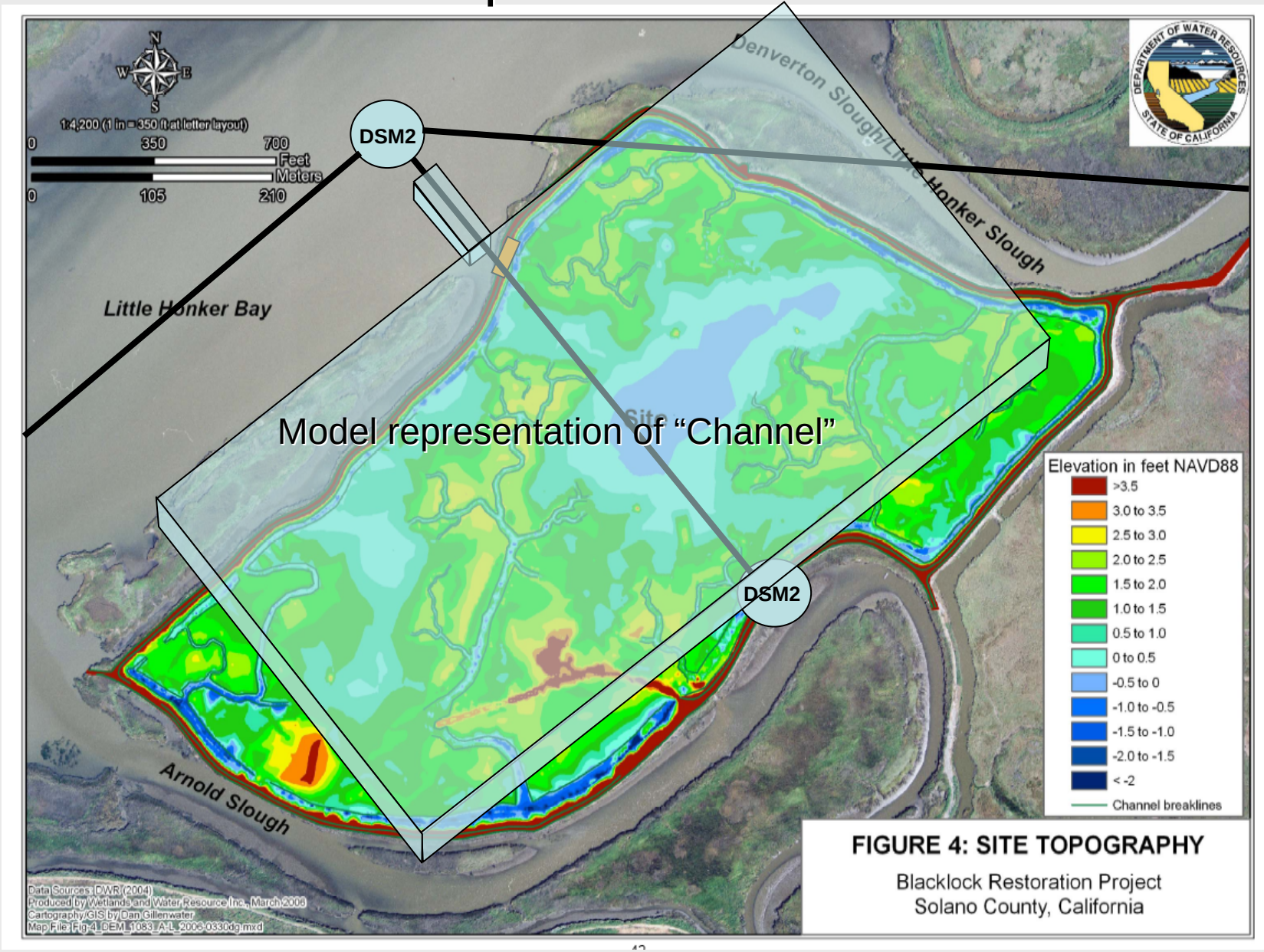


FIGURE 4: SITE TOPOGRAPHY

Blacklock Restoration Project
Solano County, California

DSM2 Representation of Blacklock



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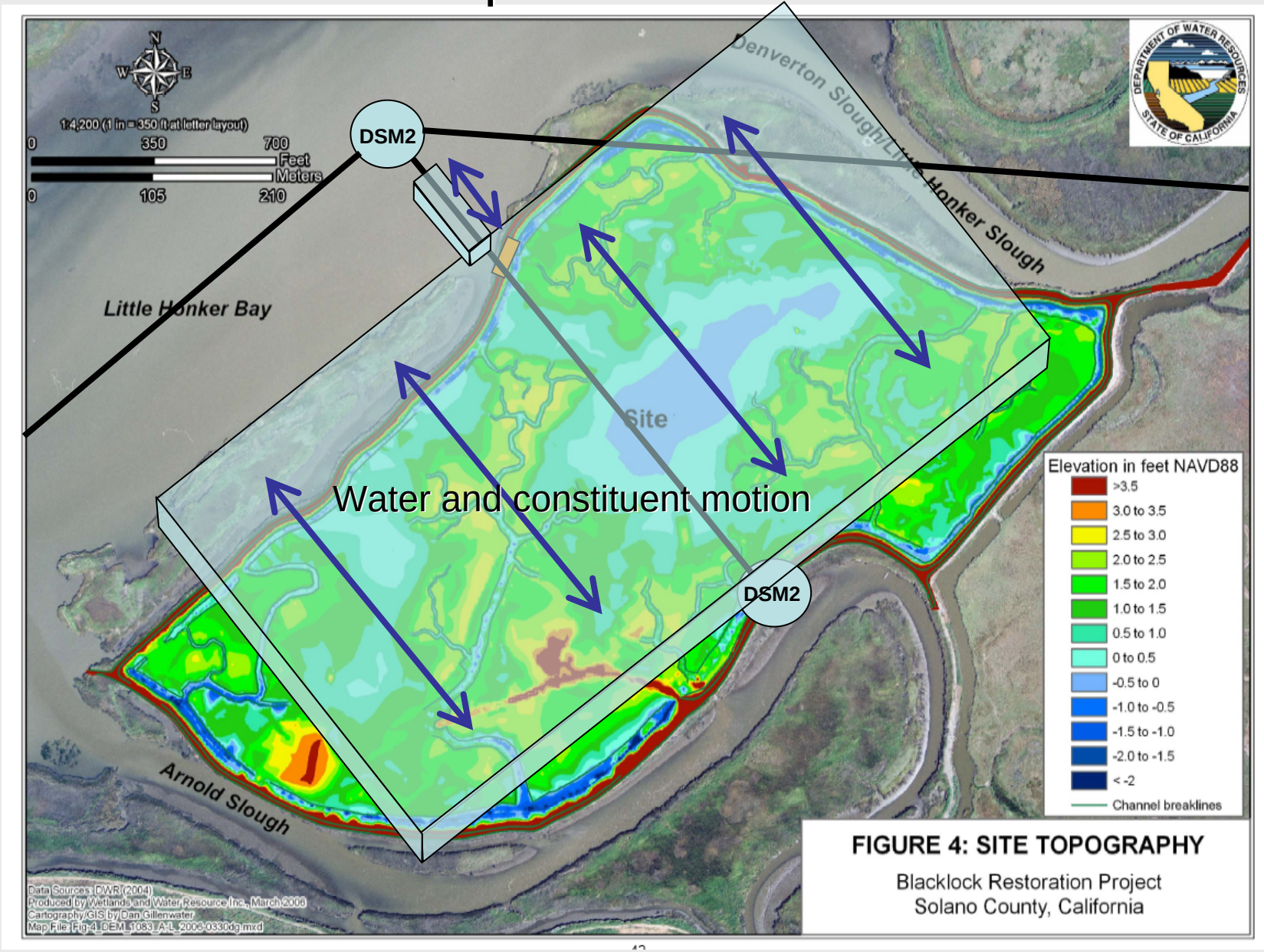

FIGURE 4: SITE TOPOGRAPHY

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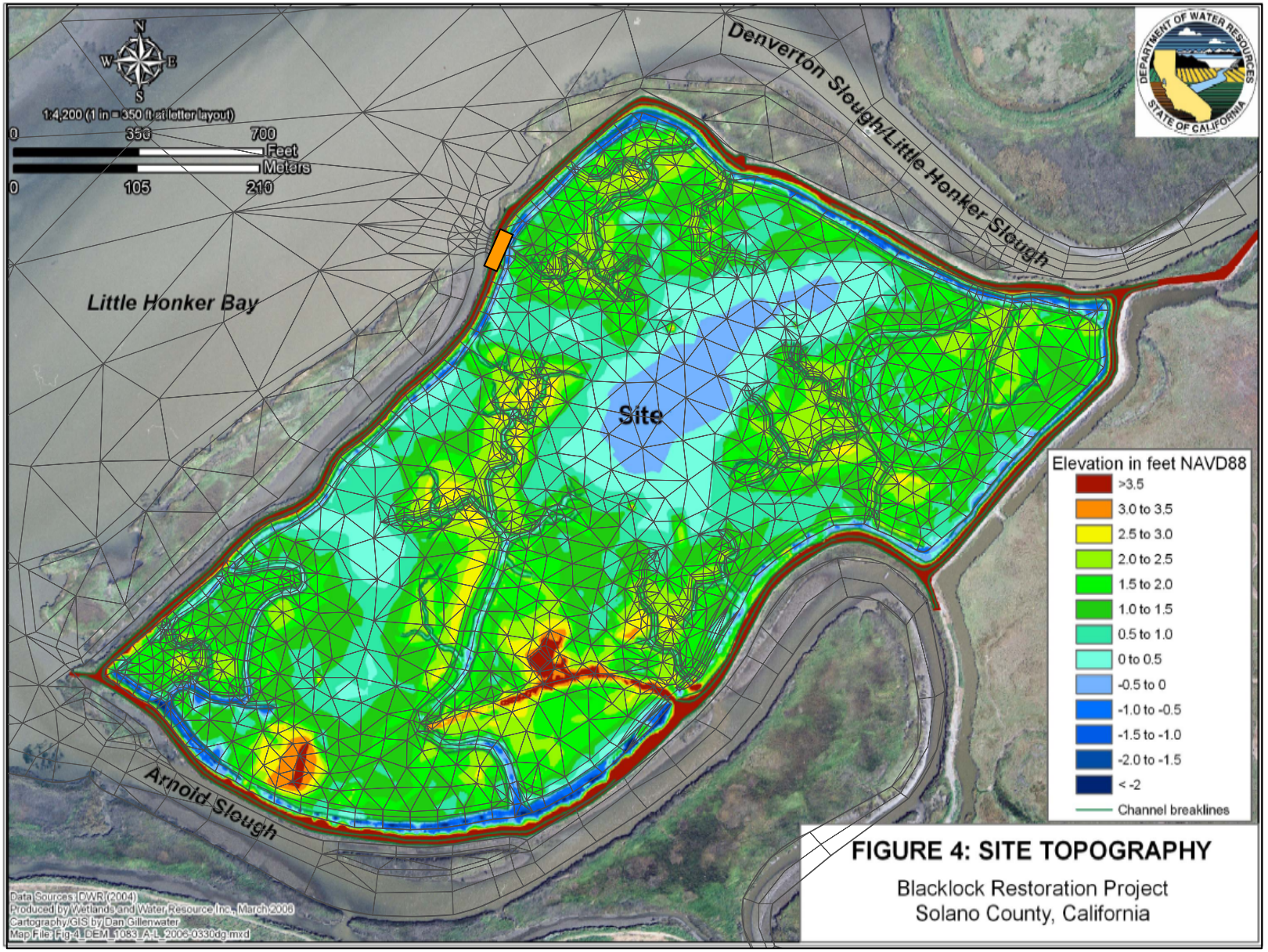
RMA Representation of Blacklock



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Blacklock Restoration Project
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RMA Velocity Field Simulation

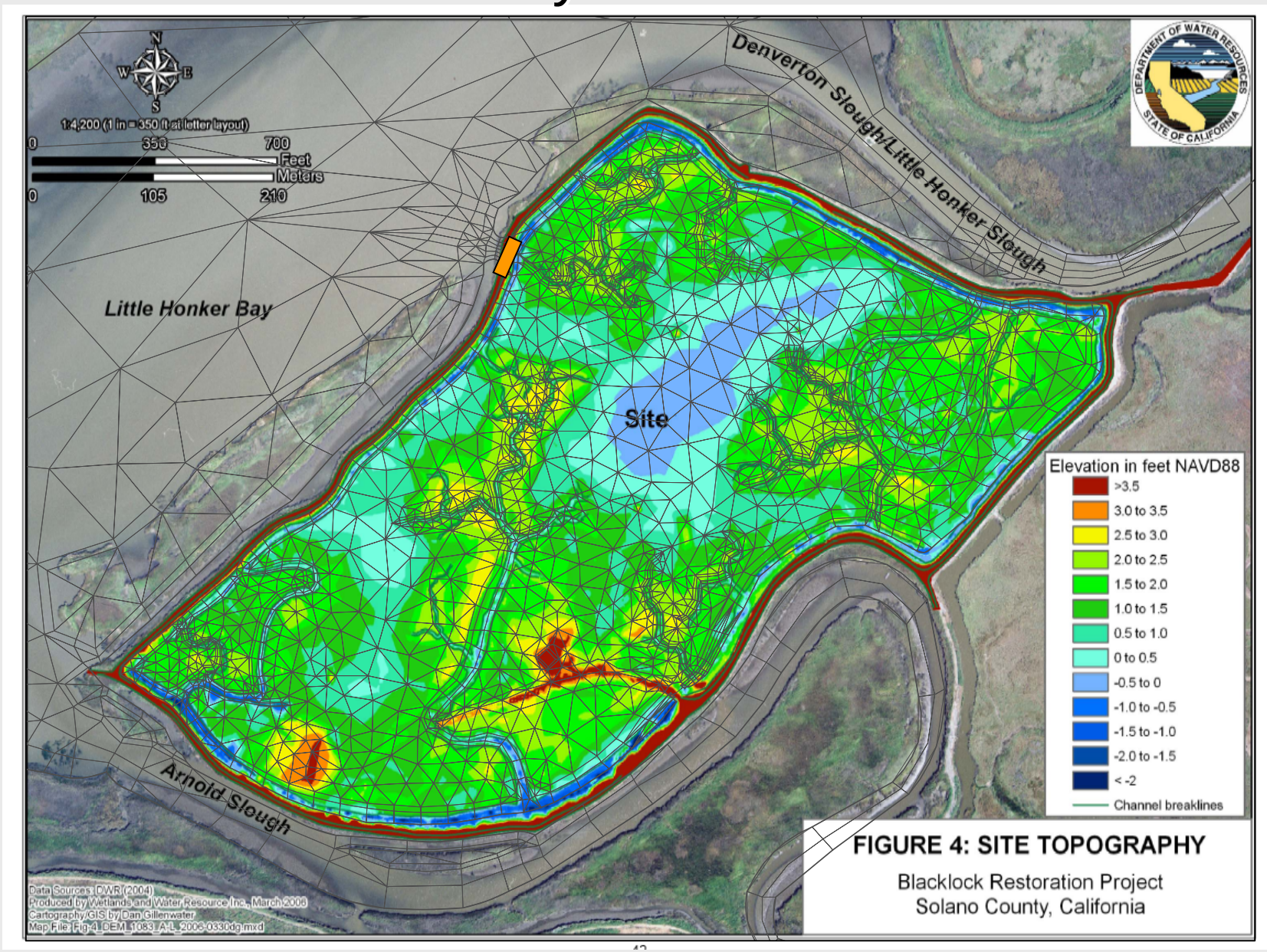


FIGURE 4: SITE TOPOGRAPHY

Blacklock Restoration Project
Solano County, California

3. 1995 WQCP modeling

- 1994 accord provided for additional spring outflow
- Modeling by Kamyar Guivetchi showed Marsh standards could be met without additional facilities.
- SMPA amendment three: “changed conditions”--new emphasis on facilitating water management.

3. 1995 WQCP modeling

Questions

- Where, how often, and by how much, will Marsh standards be exceeded?
- How often would we operate the SMSCG to meet standards?
- What is impact of September SMSCG ops?
- *DSM1 was an adequate tool for addressing these questions.*

3. 1995 WQCP modeling

- DSM1 Model (Similar to DSM2)
- 72 year simulations
- Hydrology input from DWRSIM (CALSIM)
- Input is monthly averages (Sac, SJR, export, etc)
- 19-year mean tide…
- *So, it's very course input data*
- Model output for SWRCB 1995 WQCP report:

Where, how often, and how much would we exceed standards?

TABLE 11B-Revised

PERCENTAGE OF TIME STANDARDS ARE EXCEEDED BY STATION AND MONTH

ALTERNATIVE 3 2/

	Station	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
East	C-2	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0
	S64	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0
	S49	0.0 (0.0)	0.0 (1.7)	0.0 (0.0)	0.0 (0.0)	0.0 (1.7)	0.0 (0.0)	0.0 (0.0)	0.0
West	S42	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (1.7)	1.4 (0.0)	0.0 (0.0)	0.0
	S21	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (1.7)	5.5 (0.0)	0.0 (0.0)	0.0
	S35	(40.0) 49.3	(25.0) 39.7	(8.3) 12.3	(5.0) 6.8	(3.3) 5.5	(0.0) 0.0	(0.0) 0.0	(0.0) 0.0
	S97	(46.7) 56.2	(46.7) 57.5	(16.7) 28.8	(18.3) 20.5	(36.7) 38.4	(43.3) 42.5	(0.0) 0.0	(3.3) 5.5

ALTERNATIVE 4

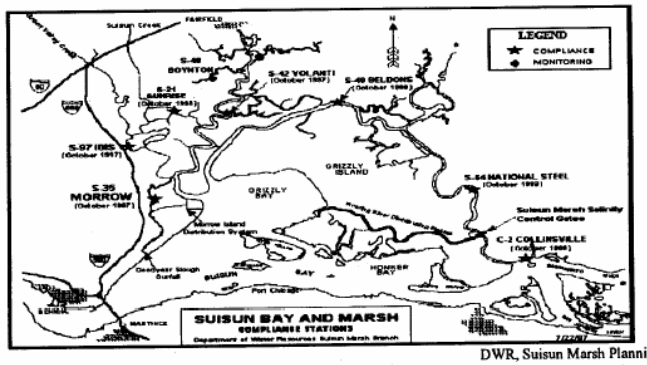
	Station	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
East	C-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West	S42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S35	49.3	30.1	4.1	1.4	16.4	0.0	0.0	0.0
	S97	20.5	2.7	0.0	0.0	12.3	0.0	0.0	0.0

ALTERNATIVE 5

	Station	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
East	C-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West	S42	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0
	S21	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0
	S35	47.9	39.7	11.0	6.8	5.5	0.0	0.0	0.0
	S97	50.7	47.9	15.1	15.1	37.0	38.4	0.0	5.5
Other	S40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ALTERNATIVE 6

	Station	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
East	C-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West	S42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S35	8.2	2.7	4.1	0.0	1.4	0.0	0.0	0.0
	S97	6.8	4.1	0.0	0.0	13.7	13.7	0.0	0.0

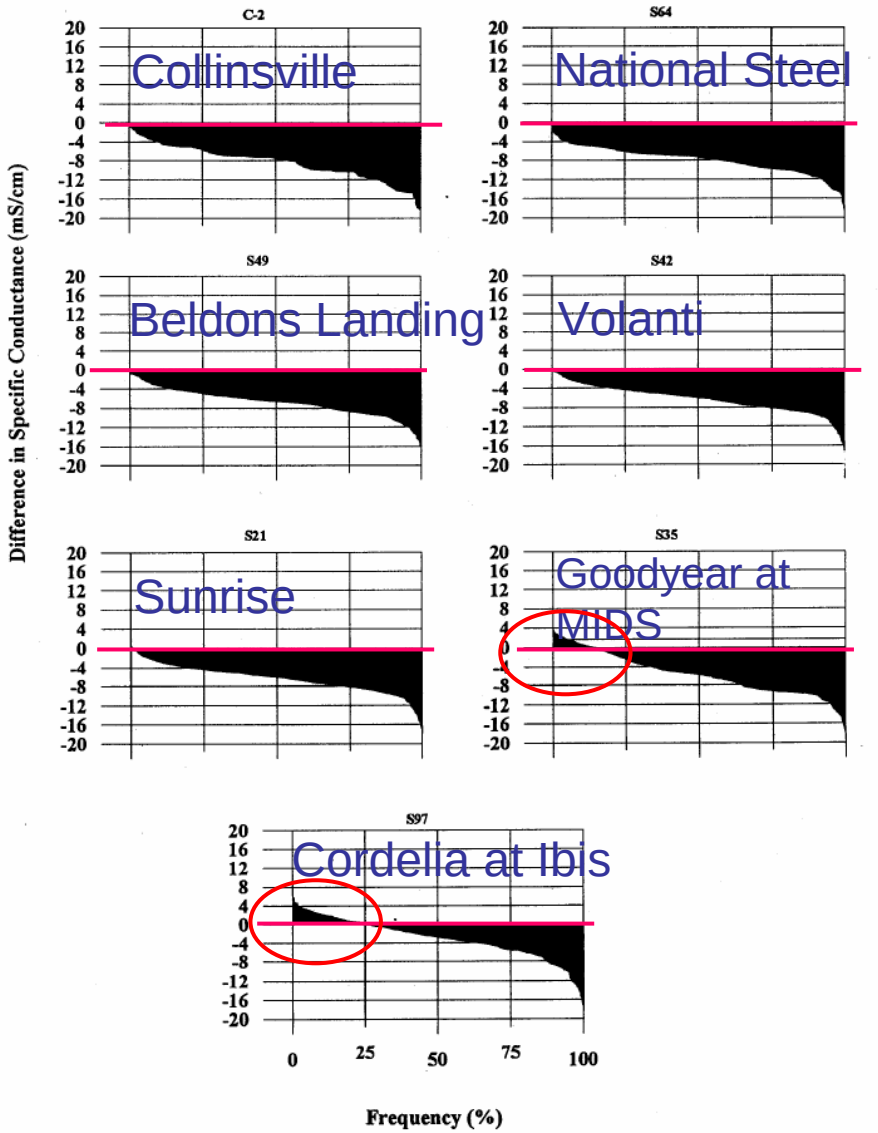


DWR, Suisun Marsh Planning
8/25/97

From SWRCB 1995 WQCP report

ALTERNATIVE 5--Revised
SALINITY AREA-FREQUENCY ANALYSIS 1/
OCTOBER THROUGH MAY OF WATER YEARS 1922-94

DWRDSM SALINITY MINUS 1995 WQCP STANDARD



Standard Exceedence Summary

FIGURE 14B – 21B - REVISED
SALINITY AREA-FREQUENCY ANALYSIS
OCTOBER THROUGH MAY OF WATER YEARS 1922-94

FOR ALTERNATIVE 5—REVISED

	SITE	Freq. Above Std. %	Exceedence Index %
East	C-2	0.0	0.0
	S-64	0.0	0.0
	S-49	0.0	0.0
West	S-42	0.0	0.0
	S-21	0.0	0.0
	S-35	13.9	3.0
	S-97	26.2	12.4

1/ Salinity was determined with DWRDSM (Suisun Marsh Version)

ALTERNATIVE:
5: WQCP standard and hydrology with September SMSCG operation

From SWRCB 1995 WQCP report

Standard Exceedence Summary

Where?

FIGURE 14B – 21B - REVISED
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Standard Exceedence Summary

Where?

How often?

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Standard Exceedence Summary

Where?

How often?

By how much?

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ALTERNATIVE:
5: WQCP standard and hydrology with September SMSCG operation

From SWRCB 1995 WQCP report

How often would we operate the SMSCG to meet standards?

TABLE 6A--Revised

SMSCG OPERATION FREQUENCY (%) 1/
OVER 73-YEARS (1922-94)
FOR ALTERNATIVE 5 (WQCP HYDROLOGY)
WITH SEPTEMBER OPERATION

By Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	56.2	64.4	45.2	42.5	41.1	28.8	2.7	9.6	0.0	0.0	0.0	38.4
By WY Type 2/												
Critical	83.3	91.7	83.3	91.7	91.7	75.0	16.7	50.0	0.0	0.0	0.0	100.0
Dry	56.3	75.0	68.8	62.5	75.0	56.3	0.0	6.3	0.0	0.0	0.0	100.0
Below Normal	50.0	57.1	50.0	50.0	42.9	21.4	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal	45.5	45.5	27.3	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wet	47.6	52.4	9.5	9.5	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
By Station 3/												
S64	31.5	30.1	9.6	16.4	15.1	6.8	2.7	9.6	0.0	0.0	0.0	0.0
S49	56.2	60.3	24.7	28.8	28.8	16.4	0.0	1.4	0.0	0.0	0.0	0.0
S42	56.2	61.6	42.5	35.6	28.8	11.0	0.0	0.0	0.0	0.0	0.0	2.7
S21	56.2	63.0	42.5	38.4	31.5	17.8	0.0	0.0	0.0	0.0	0.0	0.0
S35	56.2	53.4	43.8	26.0	17.8	1.4	0.0	0.0	0.0	0.0	0.0	38.4

1/ Values based on DWRDSM (Suisun Marsh Version) results.
2/ Number of years under each water year type for the following hydrologies:
D1485: wet = 24 yrs, above normal = 11 yrs, below normal = 10 yrs, dry = 14 yrs, and critical = 14 yrs.
WQCP: wet = 21 yrs, above normal = 10 yrs, below normal = 14 yrs, dry = 16 yrs, and critical = 12 yrs.
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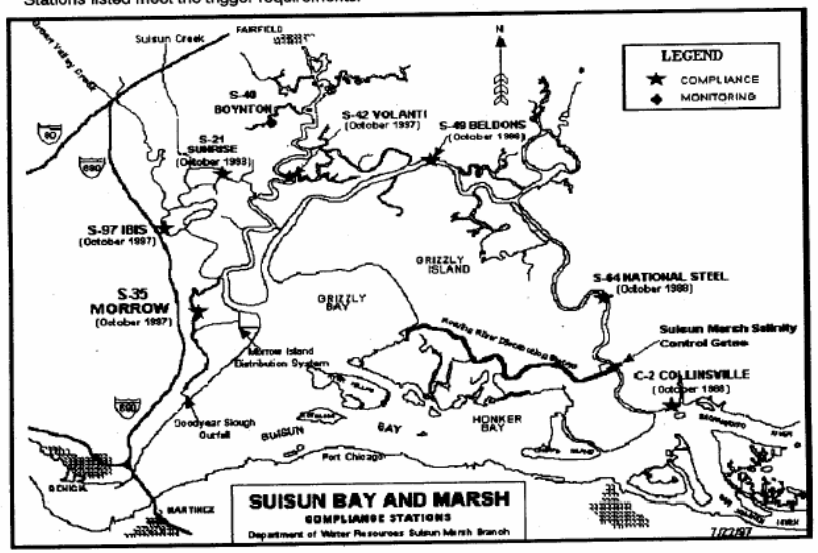
Stations listed meet the trigger requirements.



DWR, Suisun Marsh Planning
8/25/97

From SWRCB 1995 WQCP report

How often would we operate the SMSCG to meet standards?

By month

TABLE 6A--Revised

SMSCG OPERATION FREQUENCY (%) 1/
OVER 73-YEARS (1922-94)
FOR ALTERNATIVE 5 (WQCP HYDROLOGY)
WITH SEPTEMBER OPERATION

By Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	56.2	64.4	45.2	42.5	41.1	28.8	2.7	9.6	0.0	0.0	0.0	38.4
By WY Type 2/												
Critical	83.3	91.7	83.3	91.7	91.7	75.0	16.7	50.0	0.0	0.0	0.0	100.0
Dry	56.3	75.0	68.8	62.5	75.0	56.3	0.0	6.3	0.0	0.0	0.0	100.0
Below Normal	50.0	57.1	50.0	50.0	42.9	21.4	0.0	0.0	0.0	0.0	0.0	0.0
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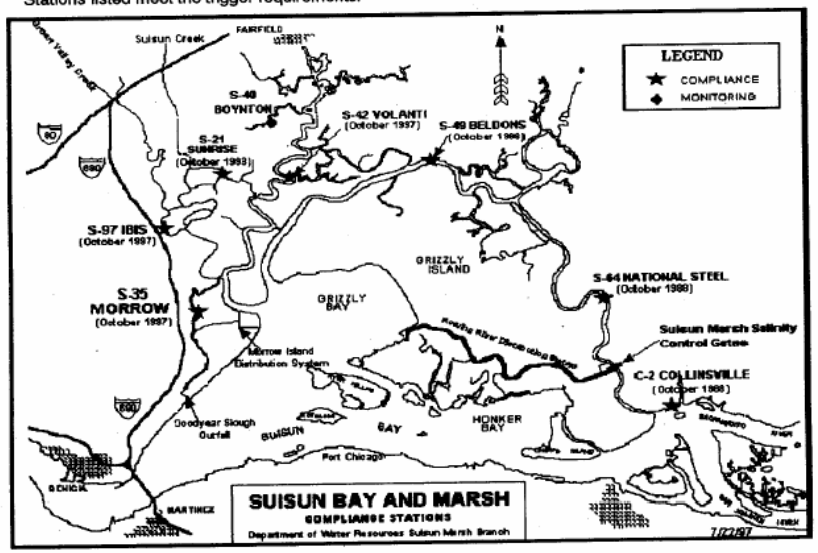

DWR, Suisun Marsh Planning
8/25/97

From SWRCB 1995 WQCP report

How often would we operate the SMSCG to meet standards?

By month

By water year type

TABLE 6A--Revised

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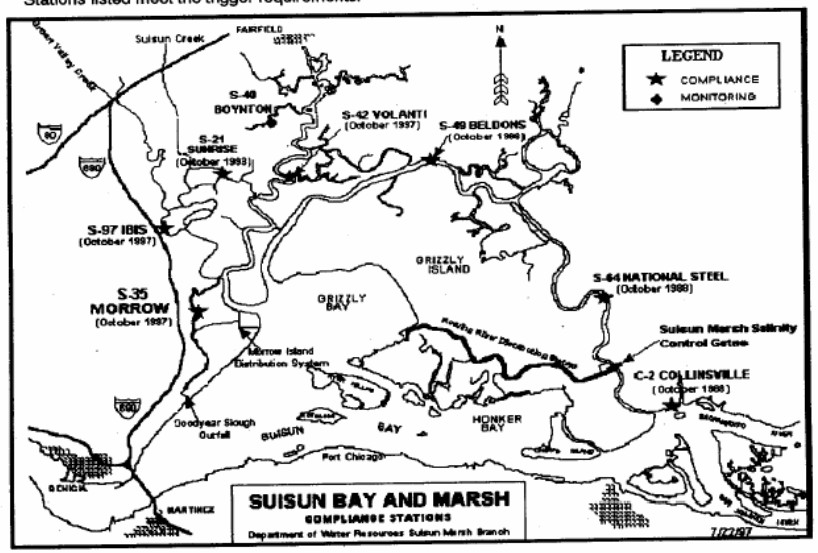

DWR, Suisun Marsh Planning
8/25/97

From SWRCB 1995 WQCP report

How often would we operate the SMSCG to meet standards?

By month

By water year type

By station

TABLE 6A--Revised

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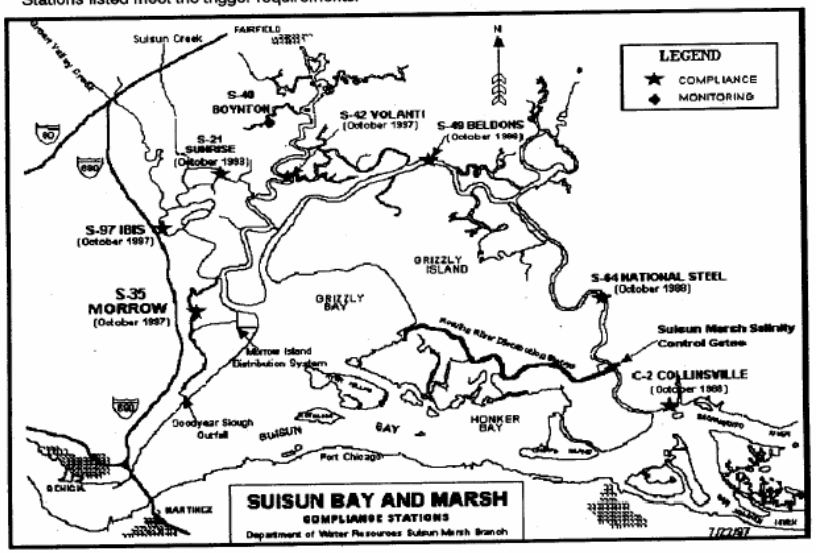

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8/25/97

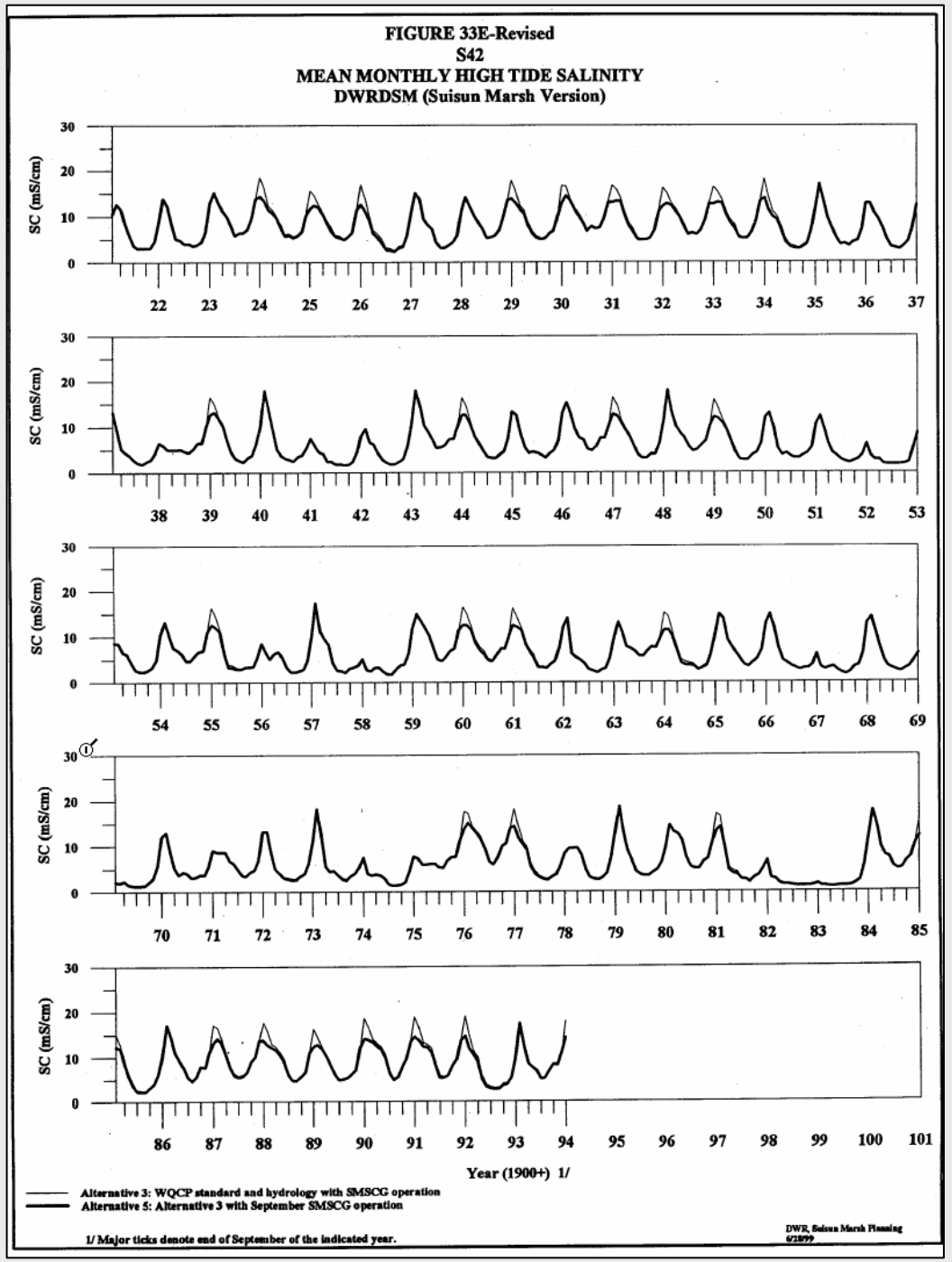
From SWRCB 1995 WQCP report

What is the impact of September SMSCG operation over 73-years?

With Sept gate operations ——

Without Sept gate operations ——

From SWRCB 1995 WQCP report



4. CALFED Suisun Marsh Levee Investigation Team

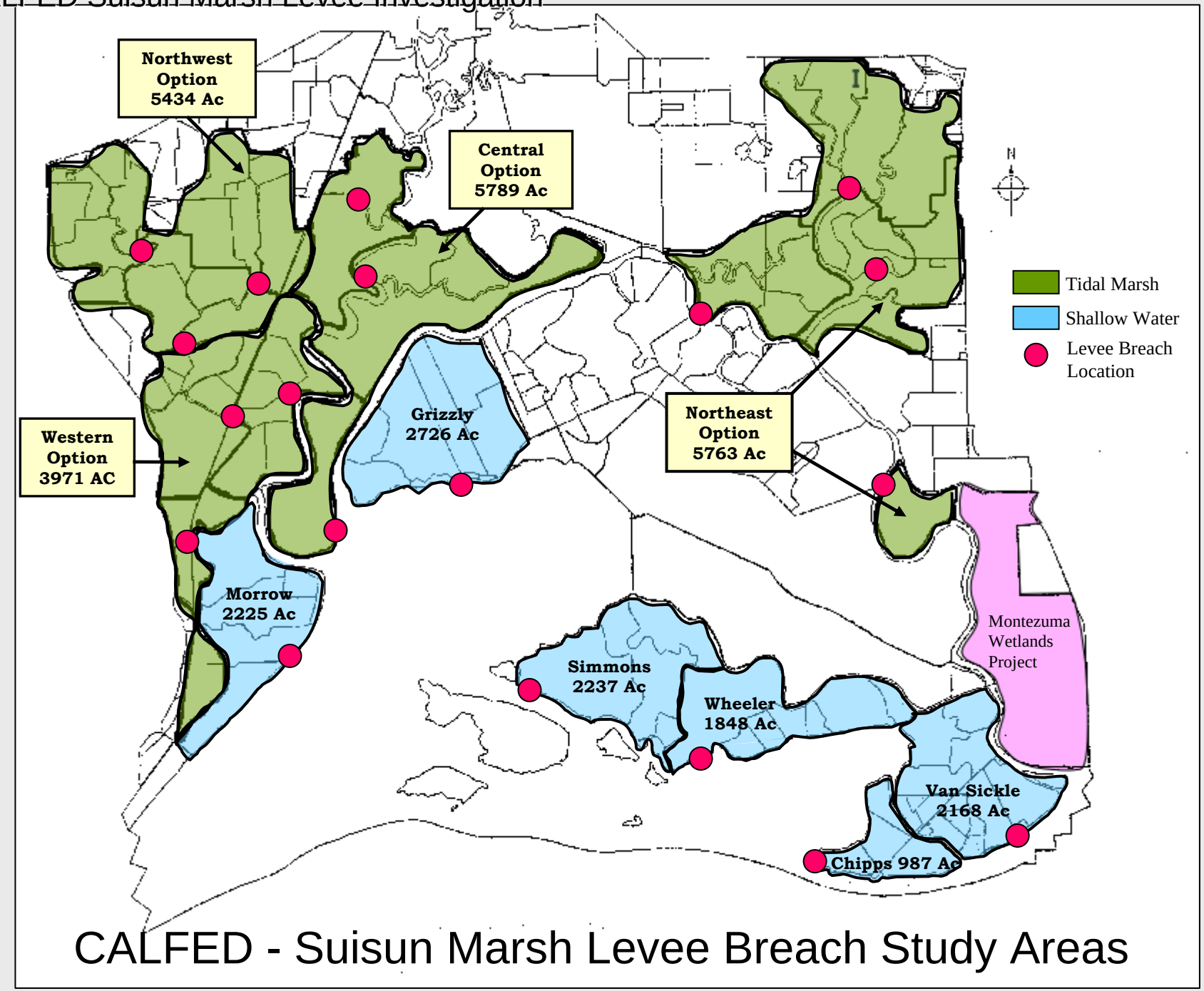
CALFED Ecosystem Restoration Goals:

- 1,500 ac. Shallow Water Habitat
- 5,000 - 7,000 ac. Tidal Marsh
- Protect 40,000 - 50,000 acres of existing Managed Wetlands

The Initial Charge to the Suisun Marsh Levee Investigation Team from CALFED:

- Should Suisun Marsh Levees be included in the CALFED Levee Program?
- If Suisun Marsh levees are added to the program, are there *opportunities* for water quality improvement and ecosystem restoration?

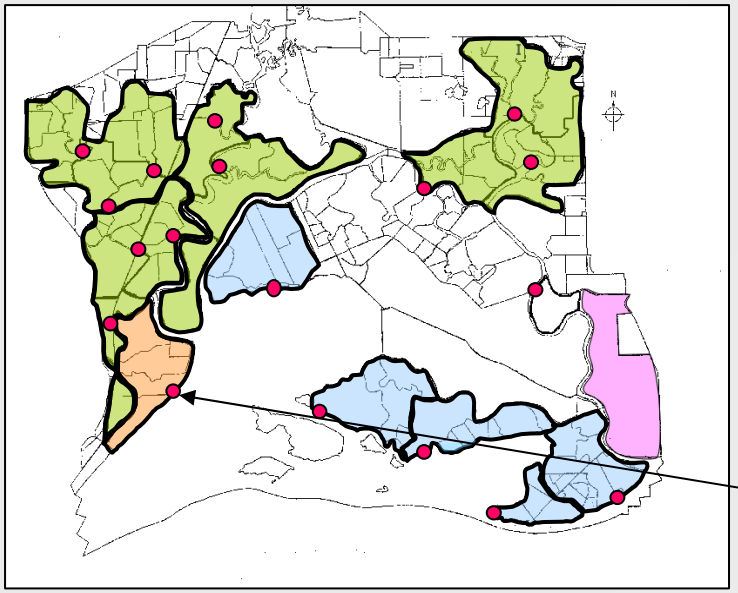
4. CALFED Suisun Marsh Levee Investigation



Summary results

- Tidal Marsh “options”
- Shallow water habitat “options”

Morrow Island 100’ Levee Breach July 29, 1992



Shallow Water Habitat Option

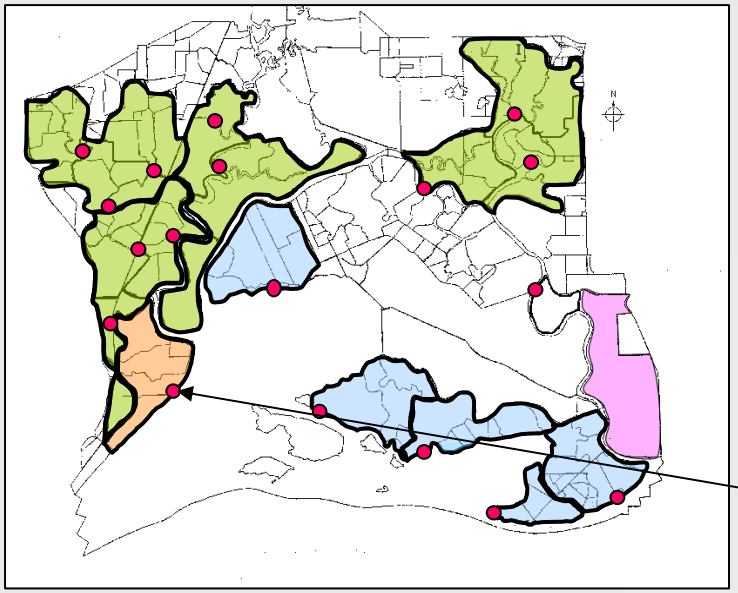
100` breach

Change From Base Condition

- <+20%
- +16-20%
- +11-15%
- +6-10%
- +0-5
- 0.0
- -0-5%
- -6-10%
- -11-15%
- -16-20%
- <-20%

4. CALFED Suisun Marsh Levee Investigation

Morrow Island 5000’ Levee Breach July 29, 1992



Shallow Water Habitat Option

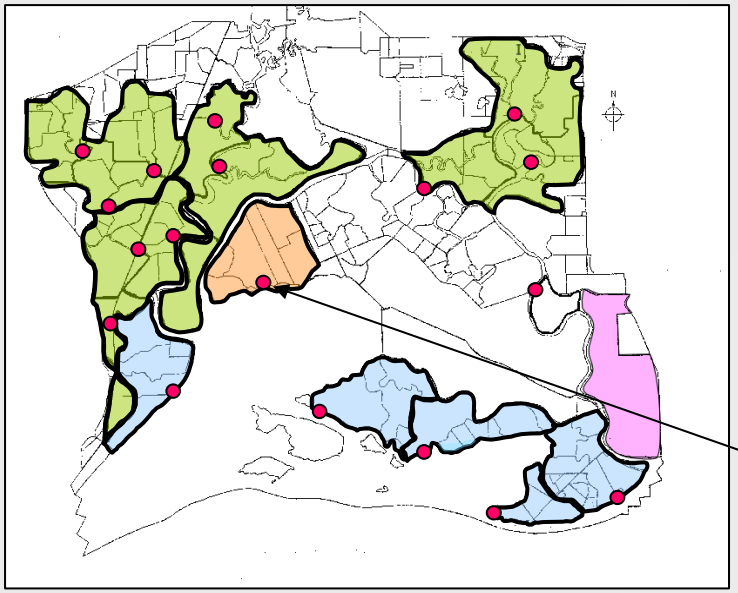
5000` breach

Change From Base Condition

- <+20%
- +16-20%
- +11-15%
- +6-10%
- +0-5
- 0.0
- -0-5%
- -6-10%
- -11-15%
- -16-20%
- <-20%

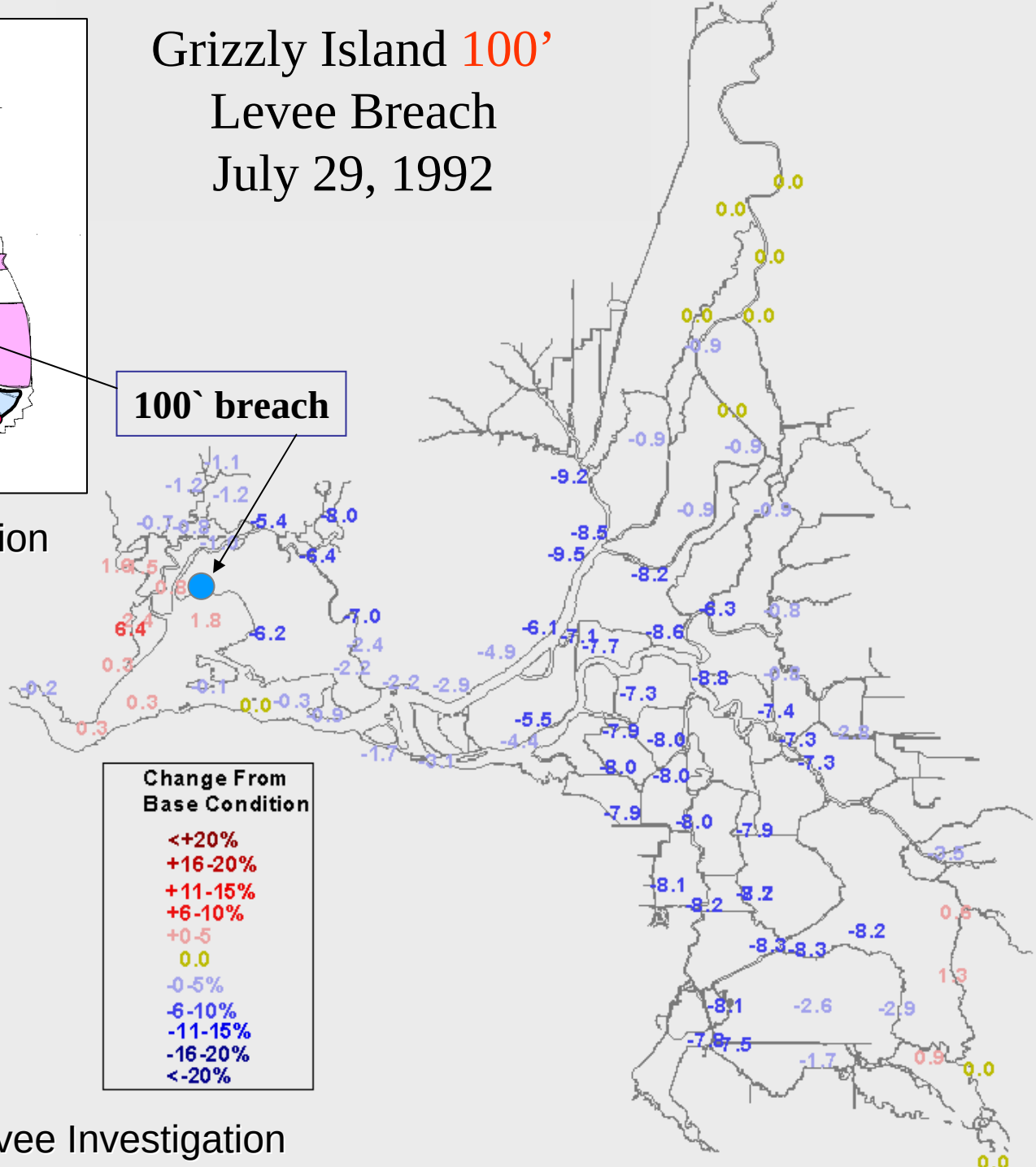
4. CALFED Suisun Marsh Levee Investigation

Grizzly Island 100’ Levee Breach July 29, 1992



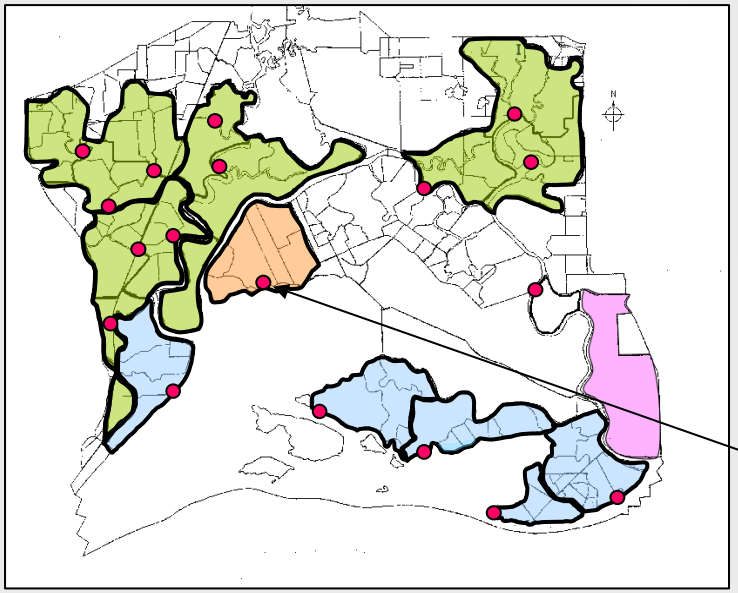
Shallow Water Habitat Option

100` breach



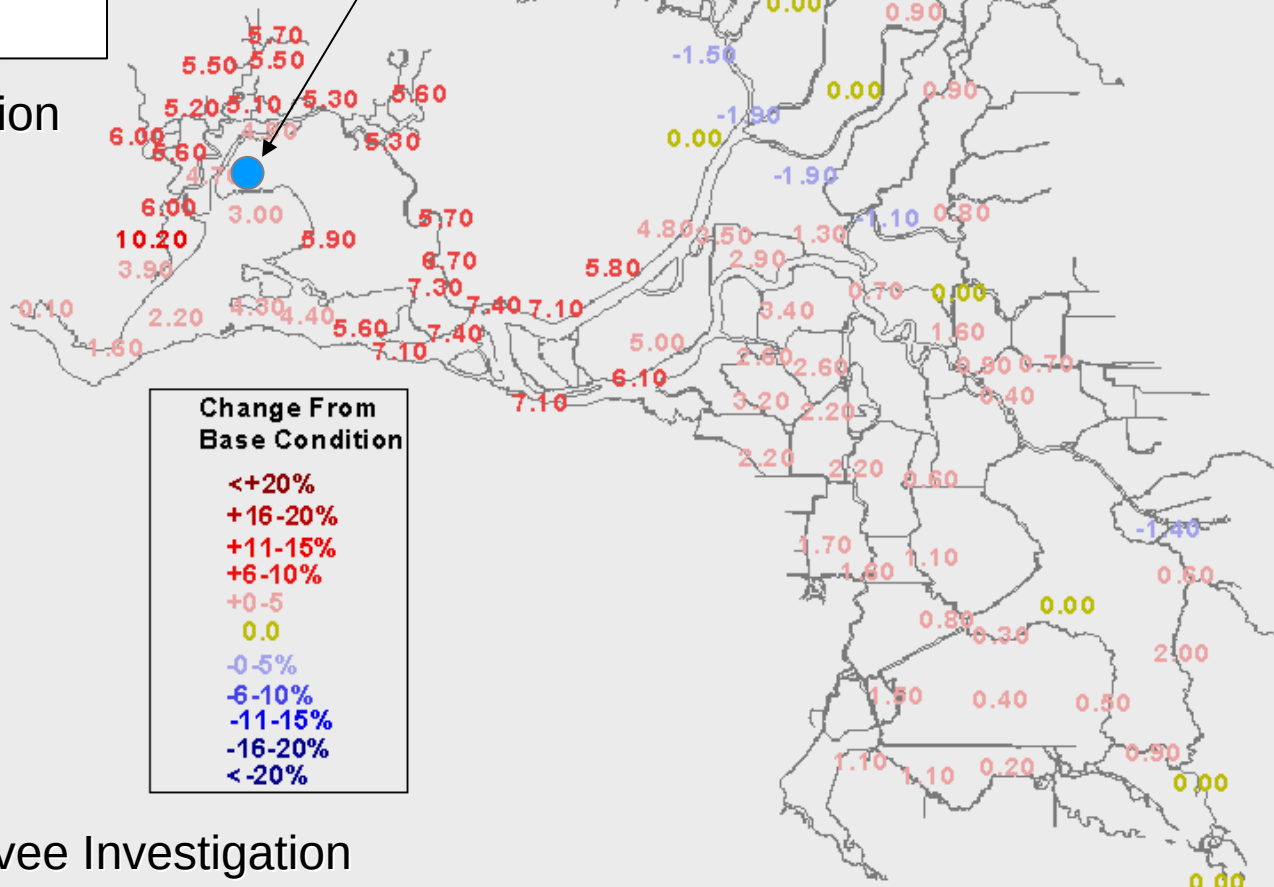
4. CALFED Suisun Marsh Levee Investigation

Grizzly Island 5000’ Levee Breach July 29, 1992



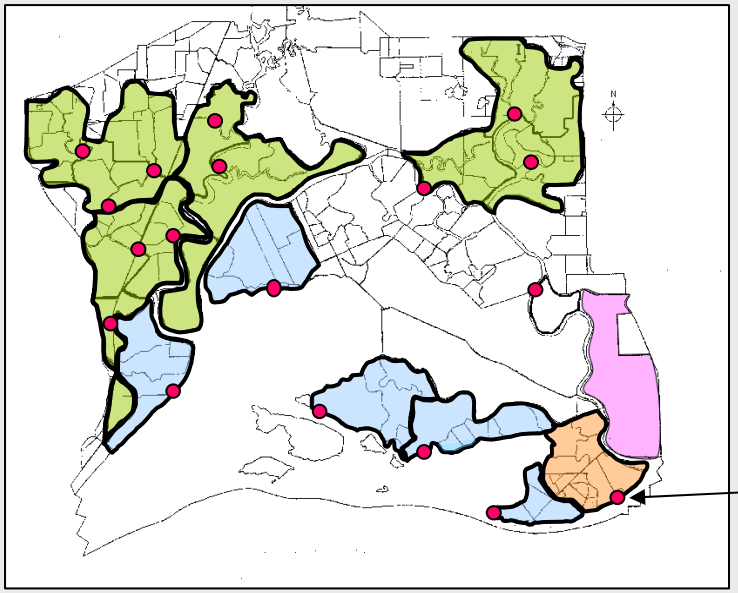
Shallow Water Habitat Option

5000` breach

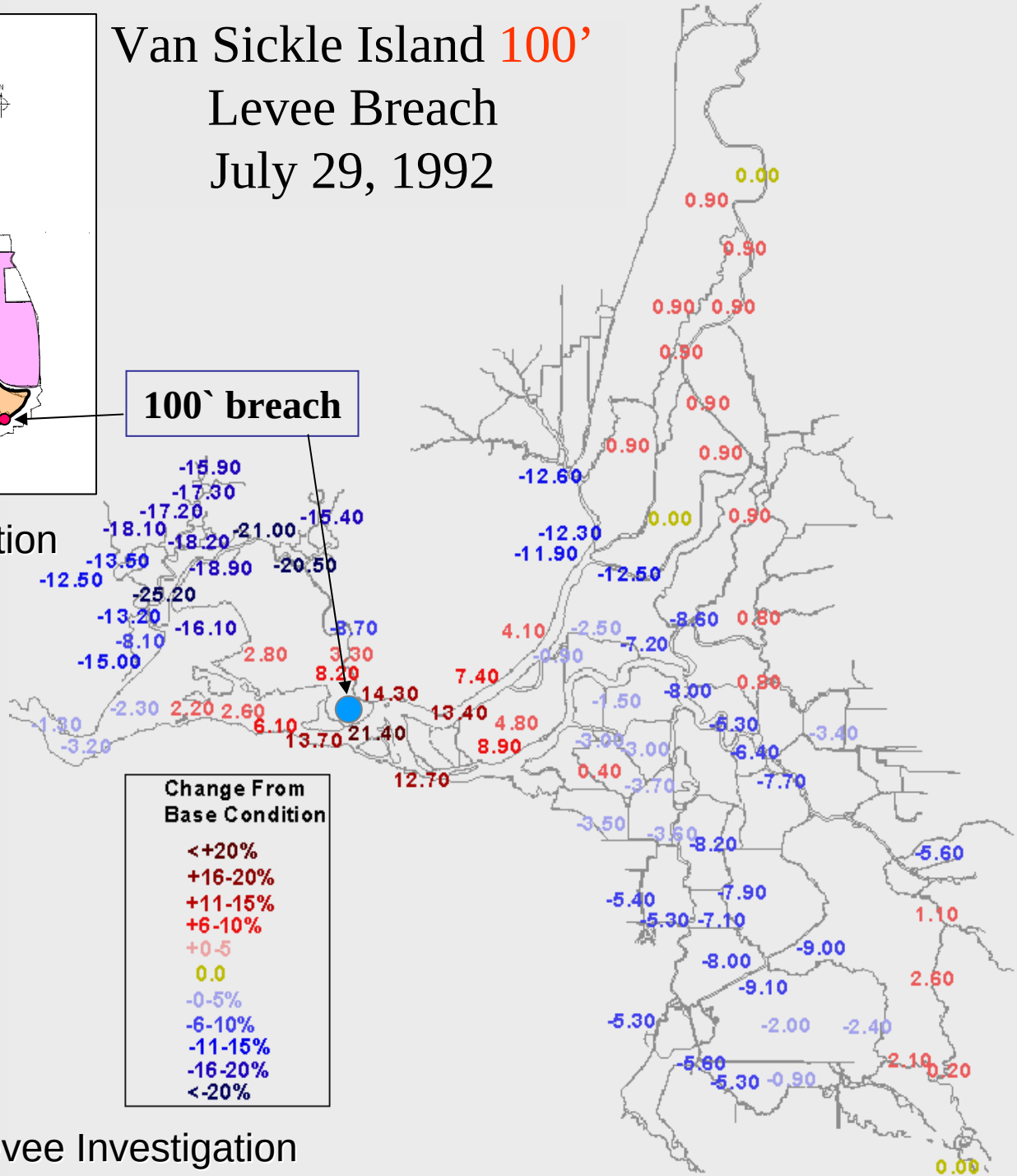


4. CALFED Suisun Marsh Levee Investigation

Van Sickle Island 100’ Levee Breach July 29, 1992

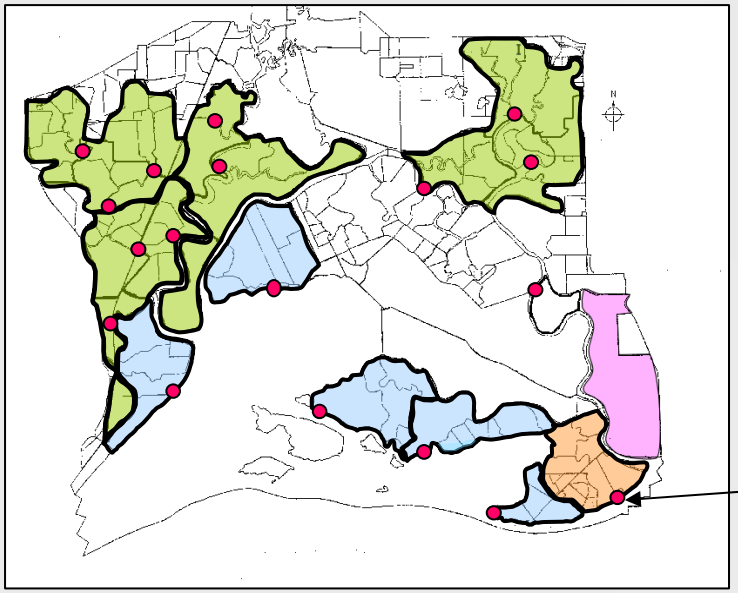


Shallow Water Habitat Option

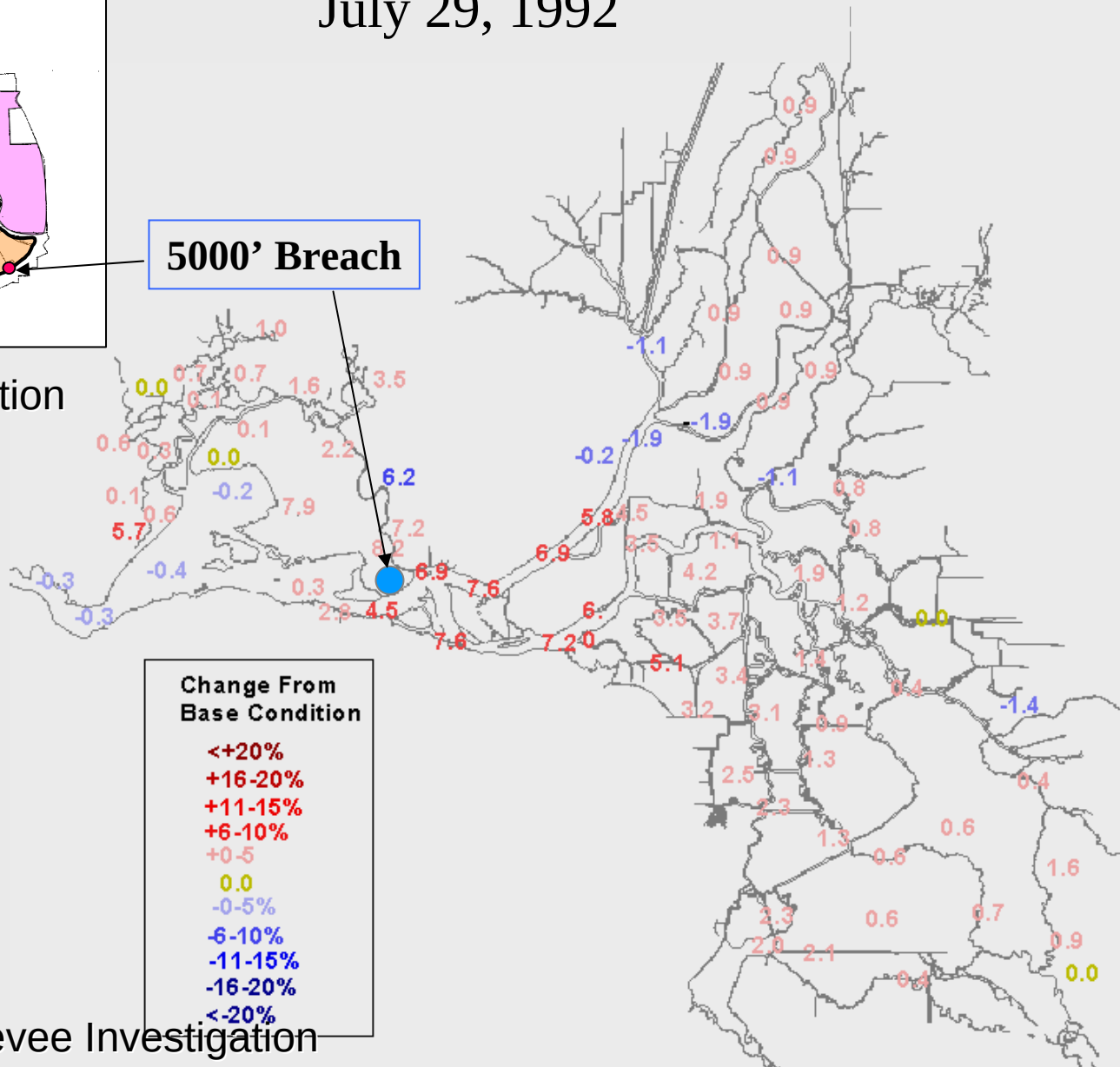


4. CALFED Suisun Marsh Levee Investigation

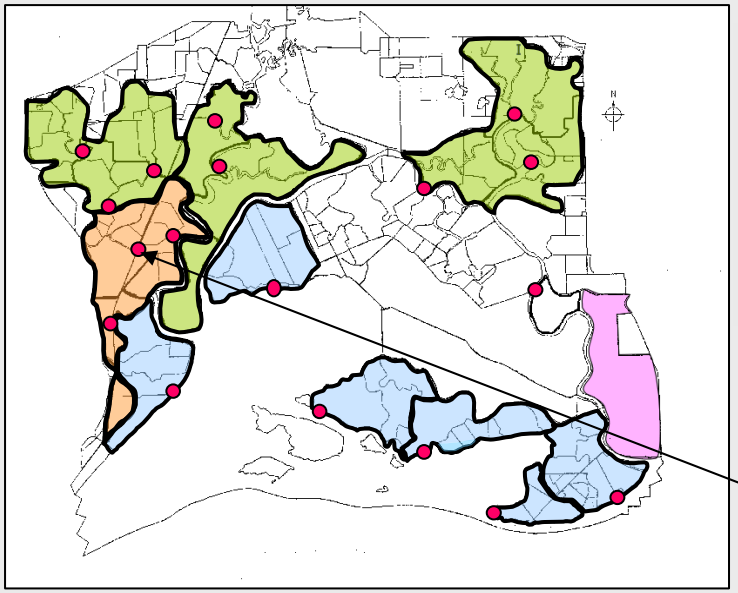
Van Sickle Island 5000’ Levee Breach July 29, 1992



Shallow Water Habitat Option



Western Tidal Marsh Option
100’ Levee Breach
July 29, 1992



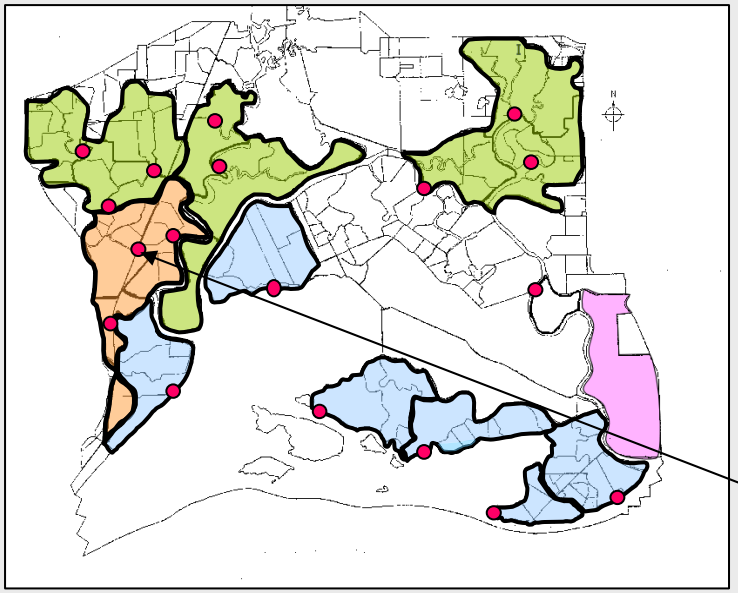
Tidal Marsh Option

100` breach

Change From Base Condition

- <+20%
- +16-20%
- +11-15%
- +6-10%
- +0-5
- 0.0
- -0-5%
- -6-10%
- -11-15%
- -16-20%
- <-20%

Western Tidal Marsh Option
5000’ Levee Breach
July 29, 1992



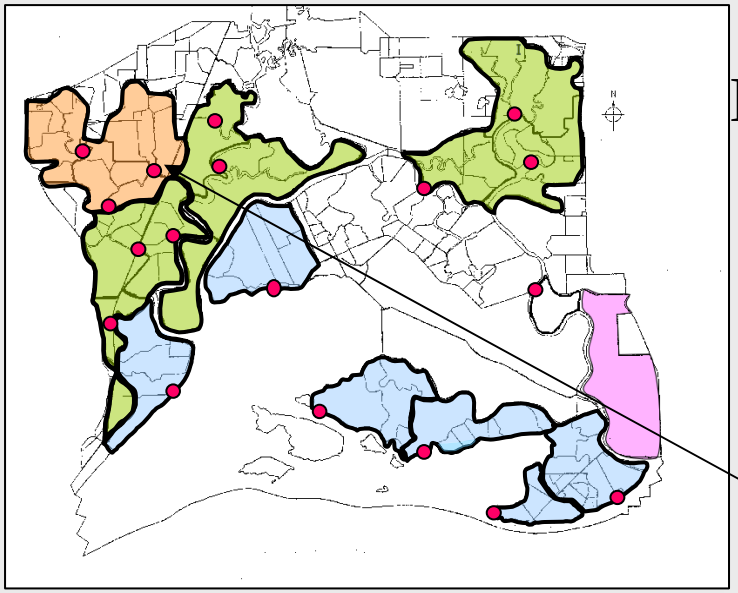
Tidal Marsh Option

5000` breach

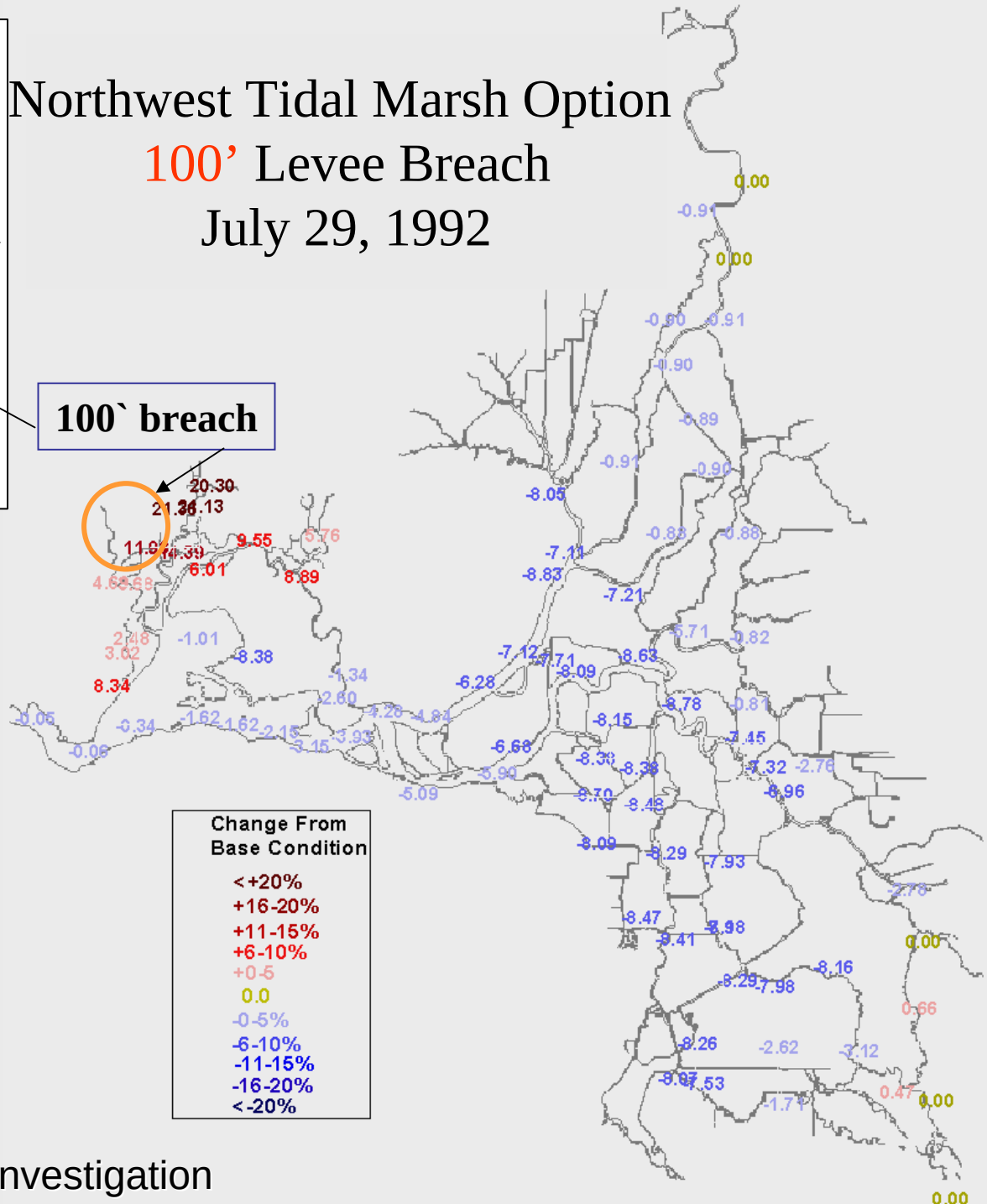
Change From Base Condition

- <+20%
- +16-20%
- +11-15%
- +6-10%
- +0-5
- 0.0
- -0-5%
- -6-10%
- -11-15%
- -16-20%
- <-20%

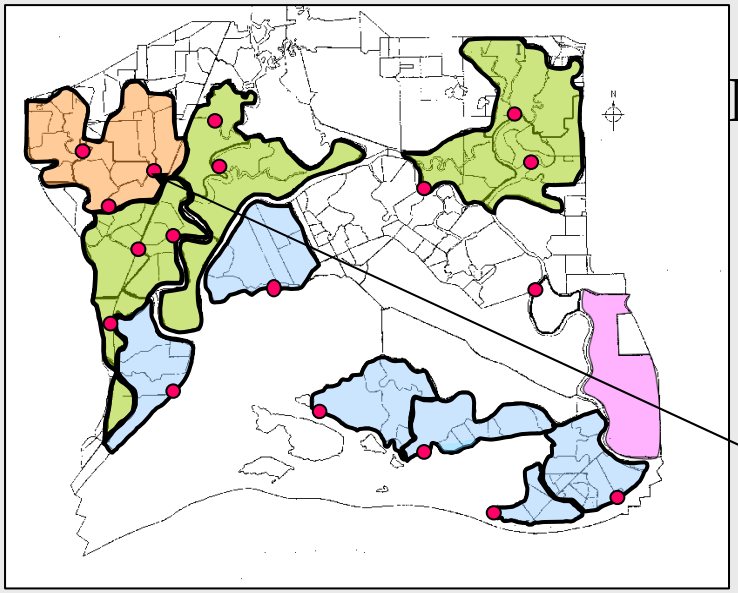
Northwest Tidal Marsh Option
100’ Levee Breach
July 29, 1992



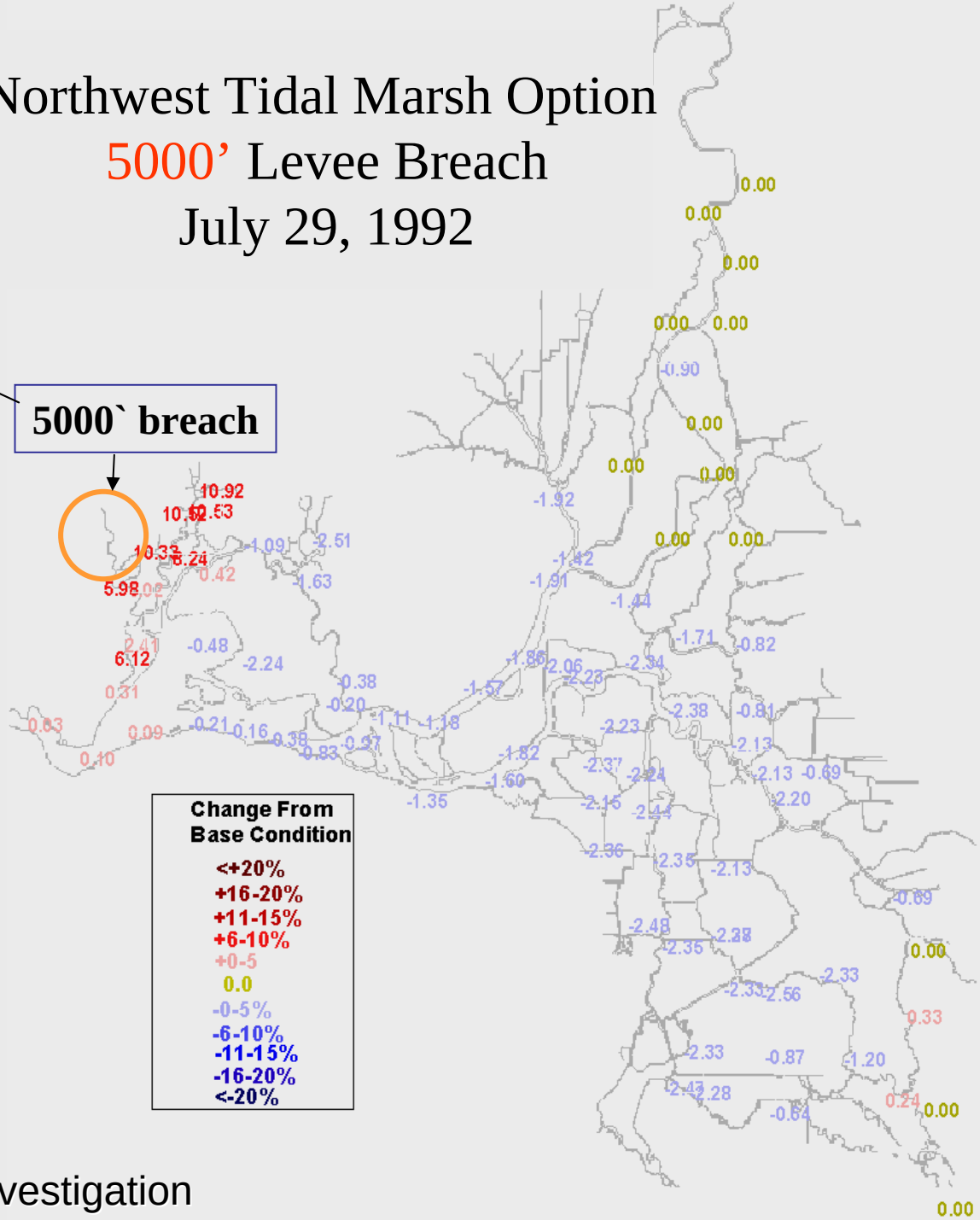
Tidal Marsh Option



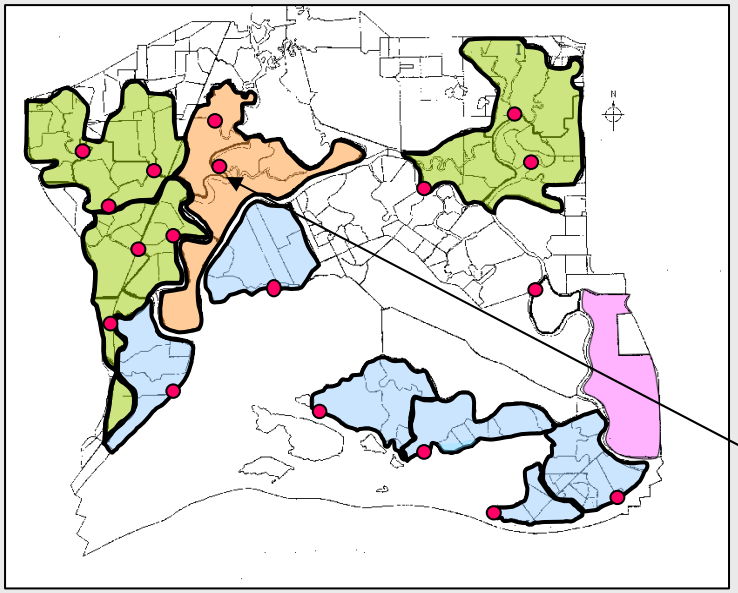
Northwest Tidal Marsh Option
5000’ Levee Breach
July 29, 1992



Tidal Marsh Option

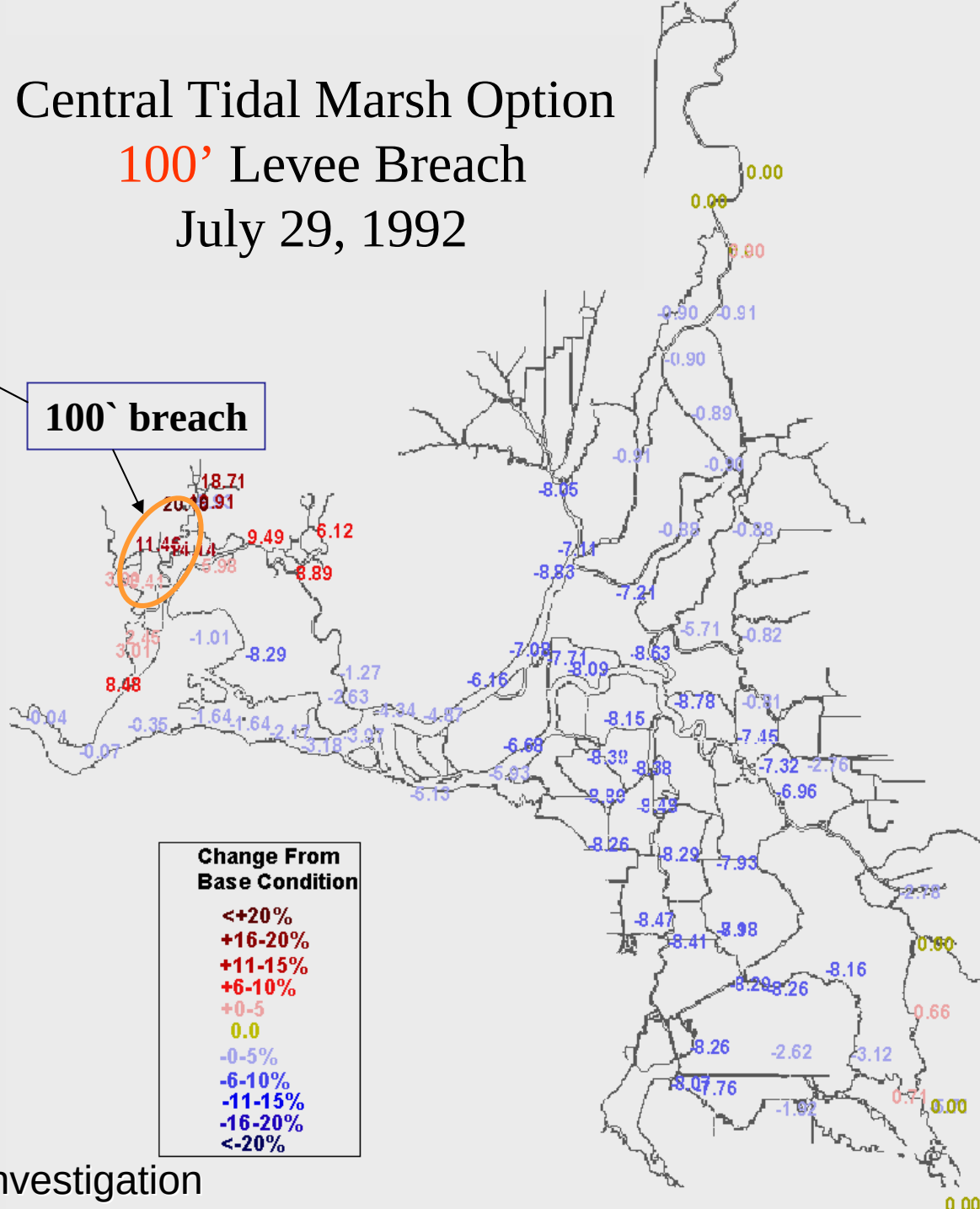


Central Tidal Marsh Option
100’ Levee Breach
July 29, 1992



Tidal Marsh Option

100` breach



Central Tidal Marsh Option
5000’ Levee Breach
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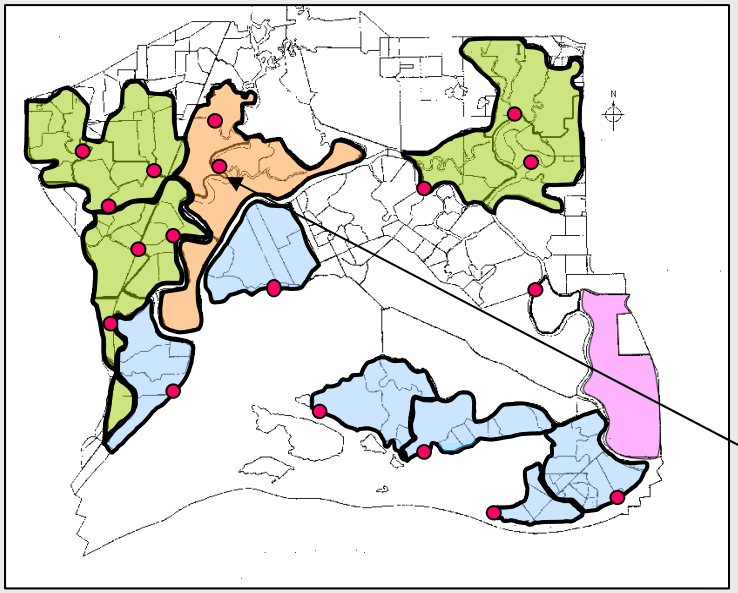


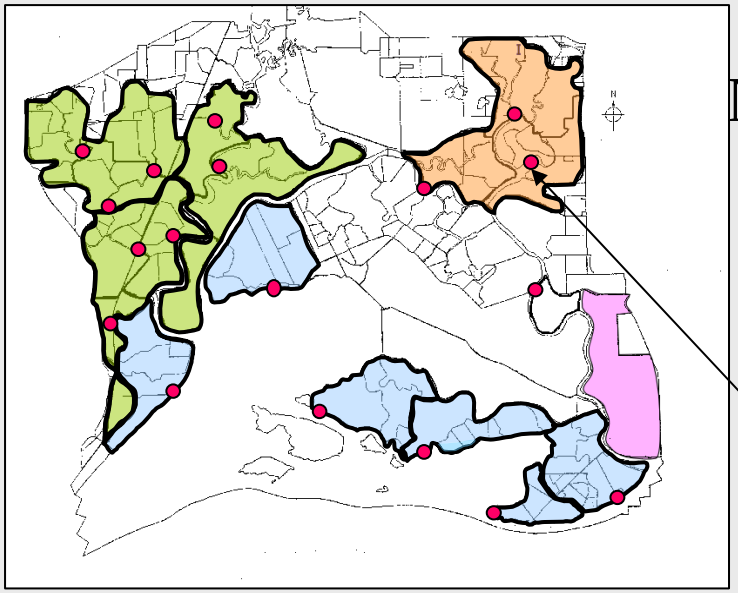
Tidal Marsh Option

5000` breach

Change From Base Condition

- <+20%
- +16-20%
- +11-15%
- +6-10%
- +0-5
- 0.0
- -0-5%
- -6-10%
- -11-15%
- -16-20%
- <-20%

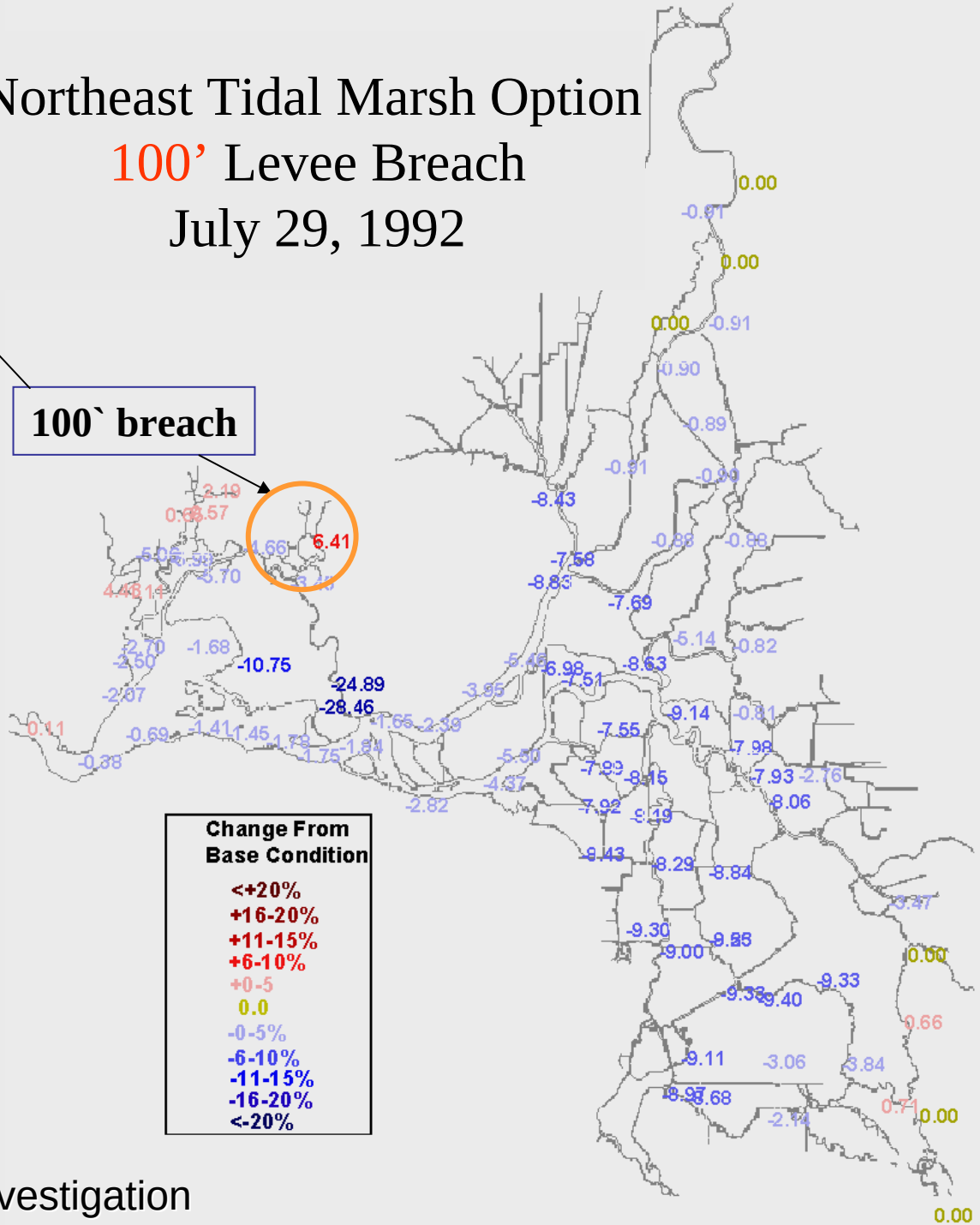
4. CALFED Suisun Marsh Levee Investigation



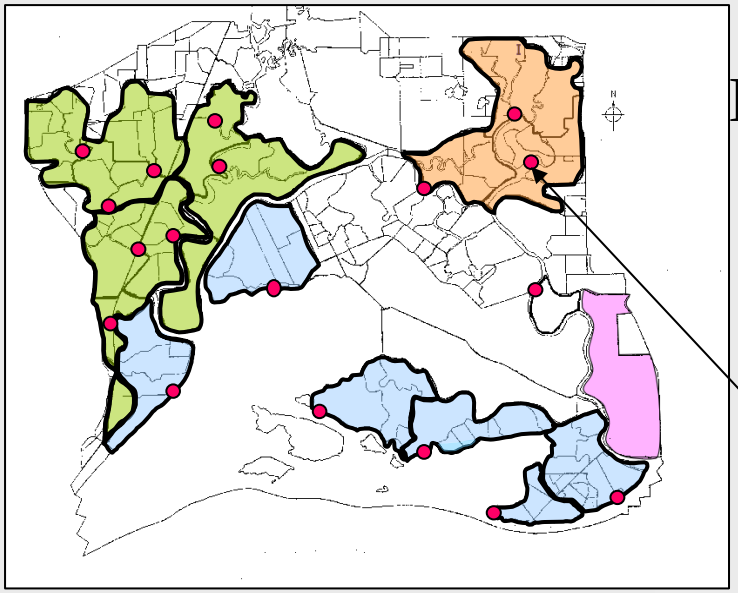
Tidal Marsh Option

Northeast Tidal Marsh Option
100’ Levee Breach
July 29, 1992

100` breach

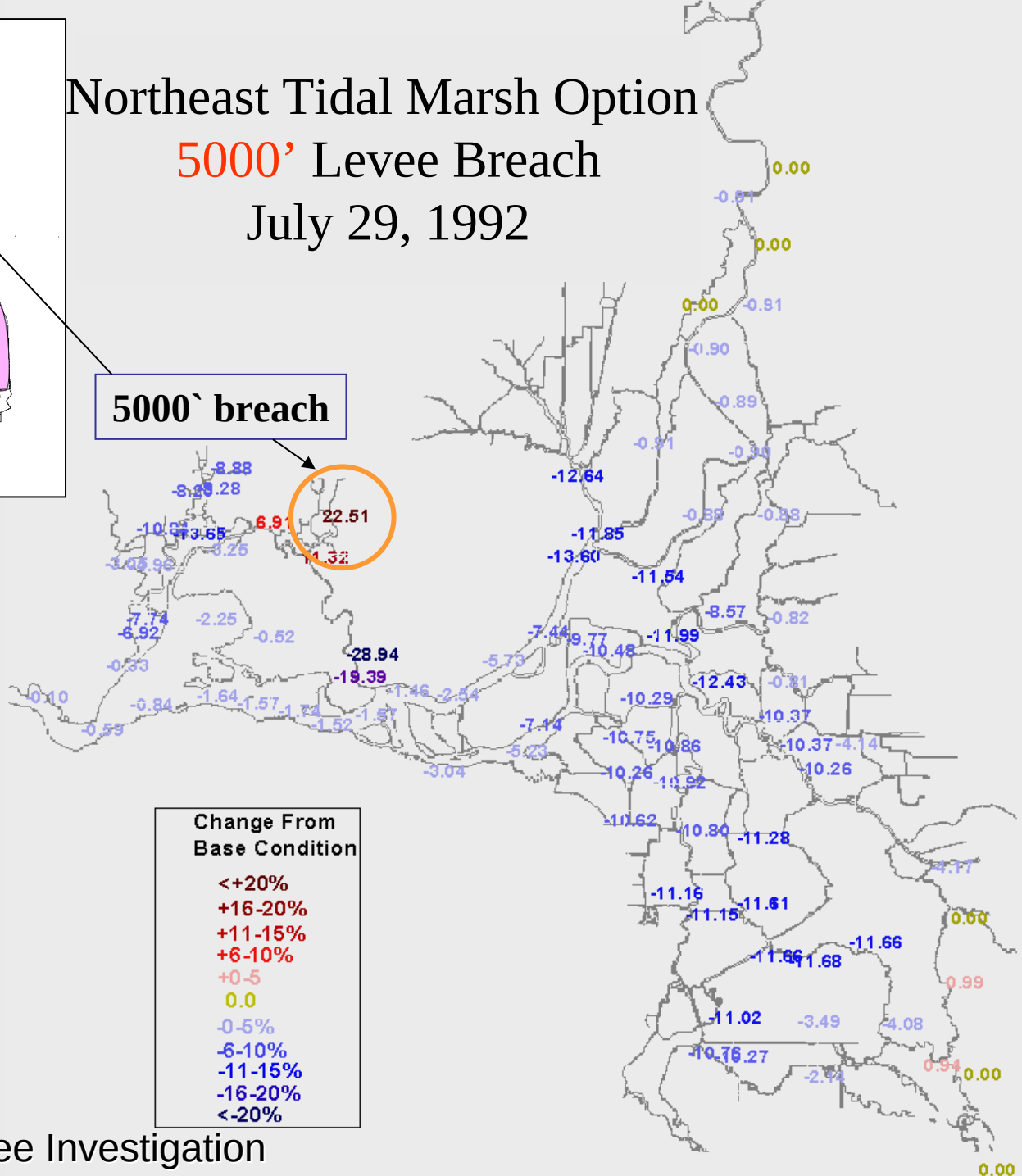


Northeast Tidal Marsh Option
5000’ Levee Breach
July 29, 1992



Tidal Marsh Option

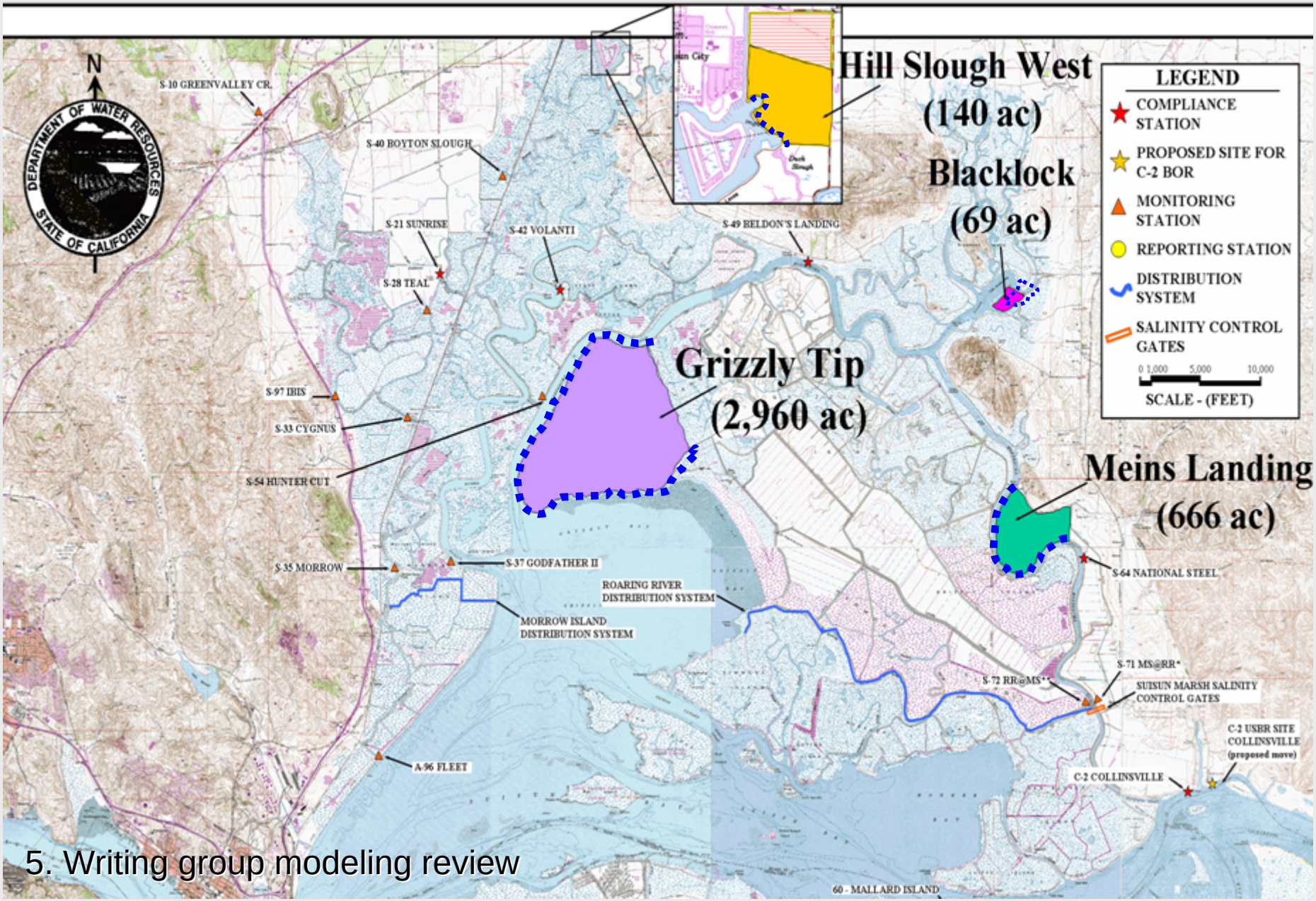
5000` breach



5. Writing group modeling review

- Hill Slough West
- Blacklock
- Meins Landing
- West Grizzly Island
- Van Sickle

Depiction of Levee Grade Down Areas



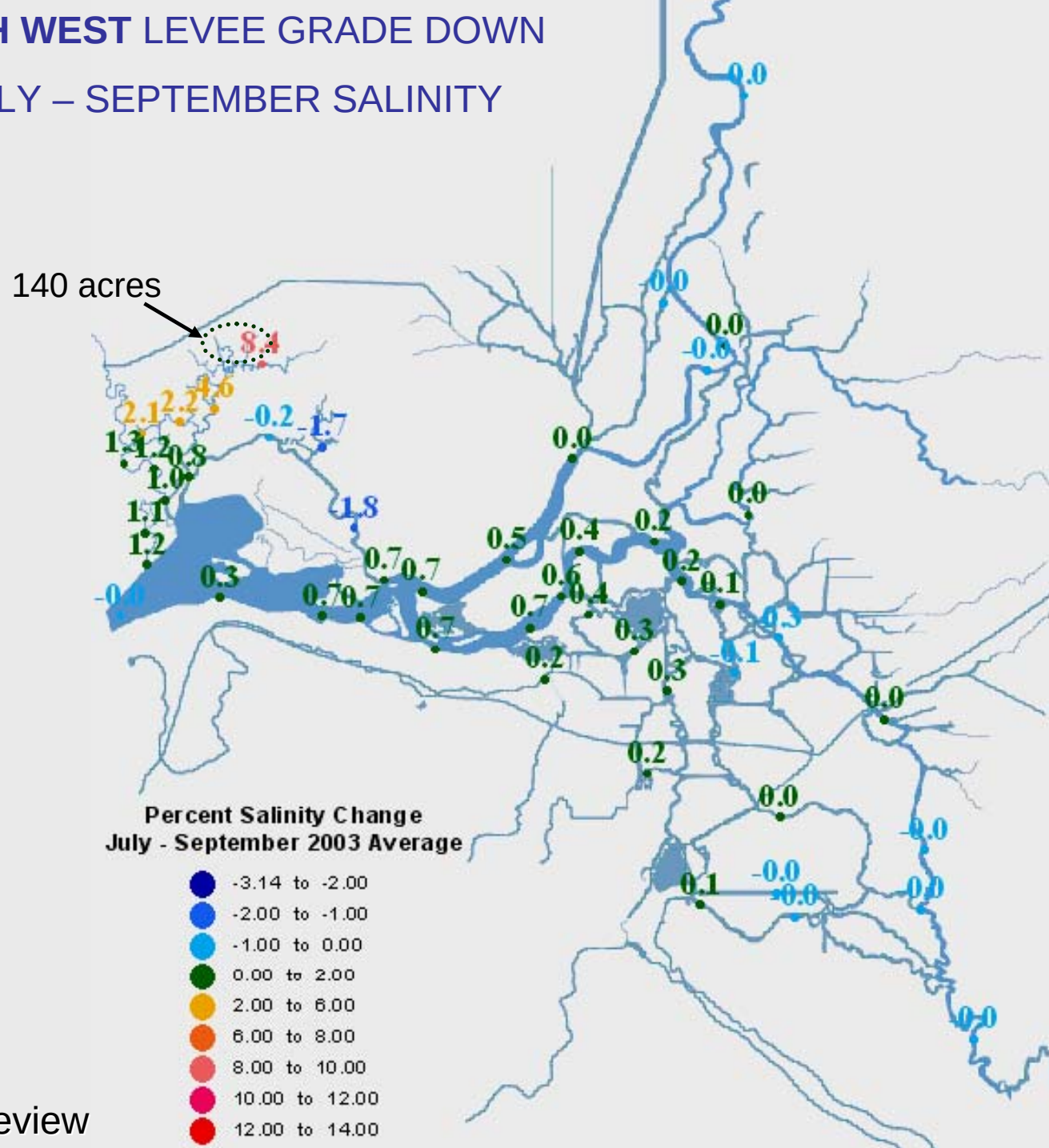
5. Writing group modeling review

IMPACT OF **HILL SLOUGH WEST** LEVEE GRADE DOWN

PERCENT CHANGE IN JULY – SEPTEMBER SALINITY

WY2003 HYDROLOGY

DSM2 MODEL



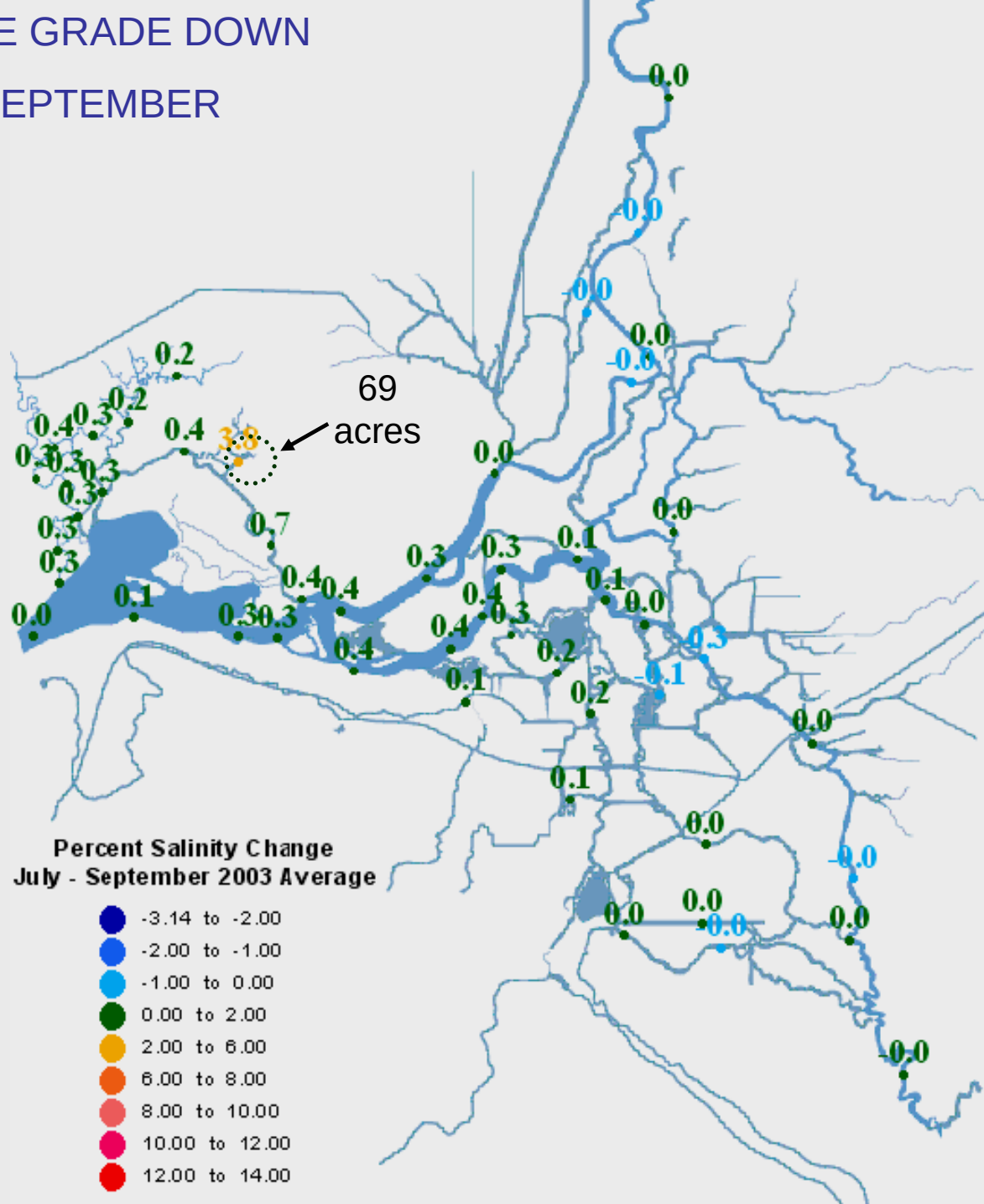
5. Writing group modeling review

IMPACT OF **BLACKLOCK** LEVEE GRADE DOWN

PERCENT CHANGE IN JULY – SEPTEMBER SALINITY

WY2003 HYDROLOGY

DSM2 MODEL

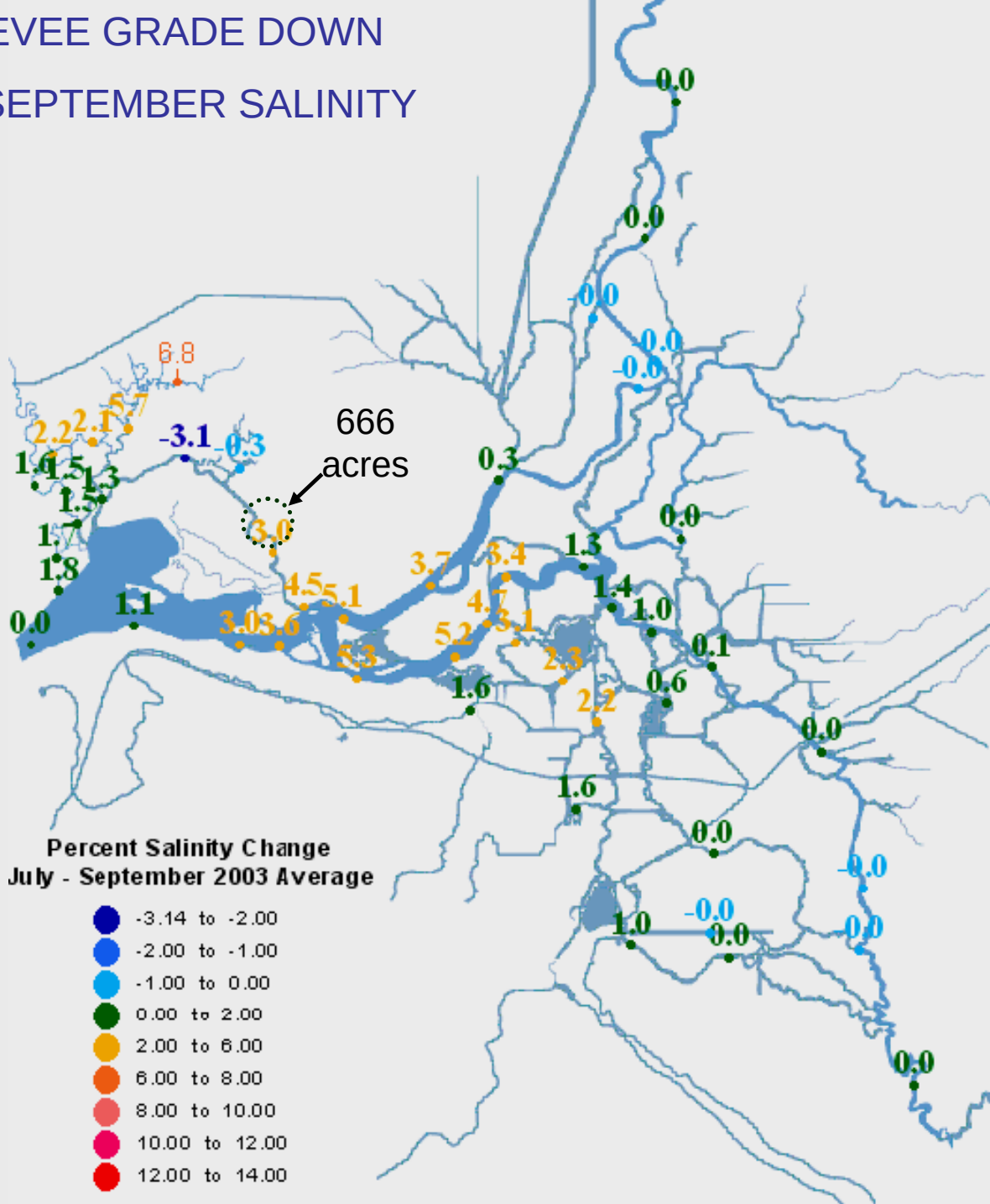


IMPACT OF **MEINS LANDING** LEVEE GRADE DOWN

PERCENT CHANGE IN JULY – SEPTEMBER SALINITY

WY2003 HYDROLOGY

DSM2 MODEL



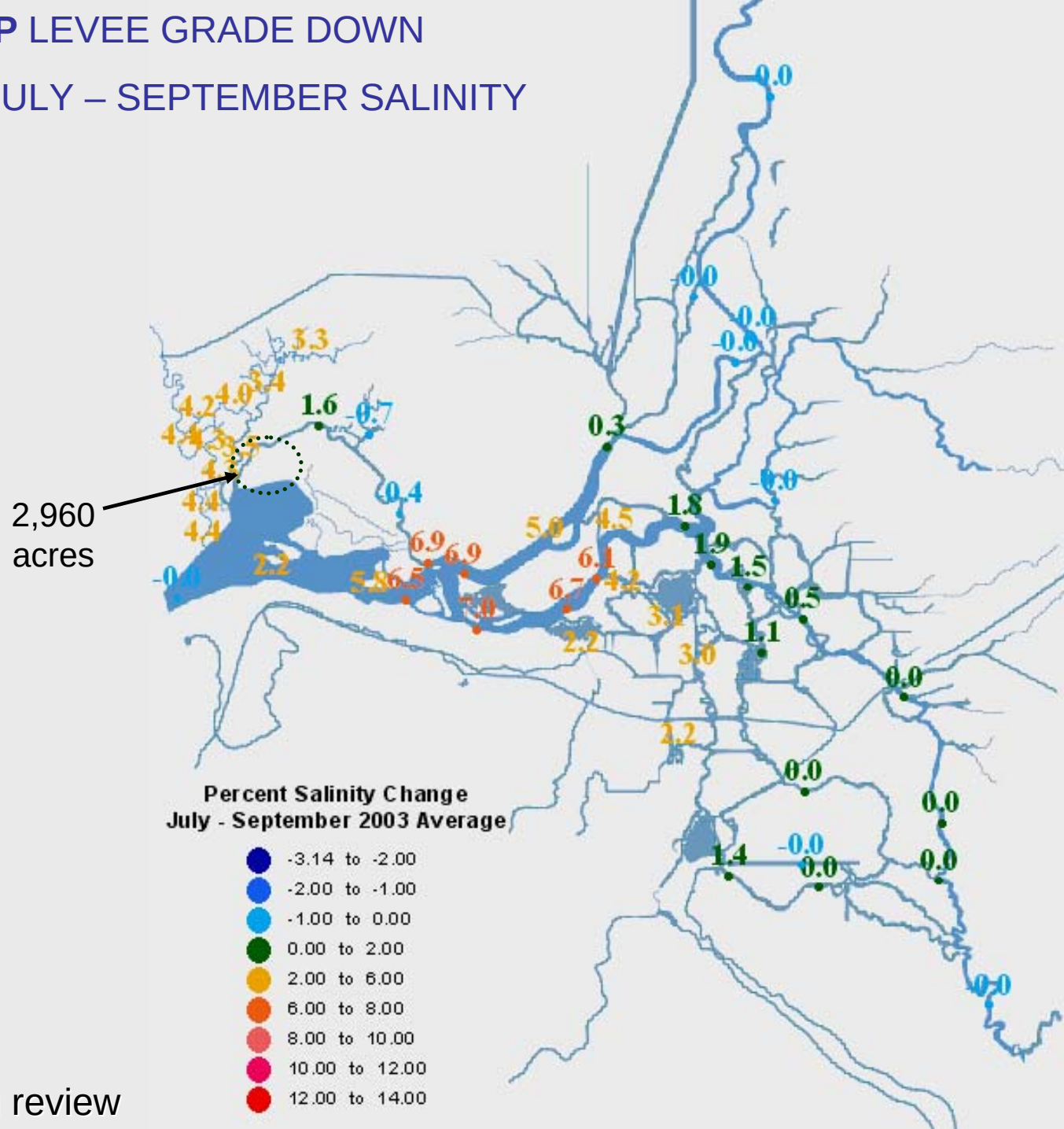
5. Writing group modeling review

IMPACT OF **GRIZZLY TIP** LEVEE GRADE DOWN

PERCENT CHANGE IN JULY – SEPTEMBER SALINITY

WY2003 HYDROLOGY

DSM2 MODEL



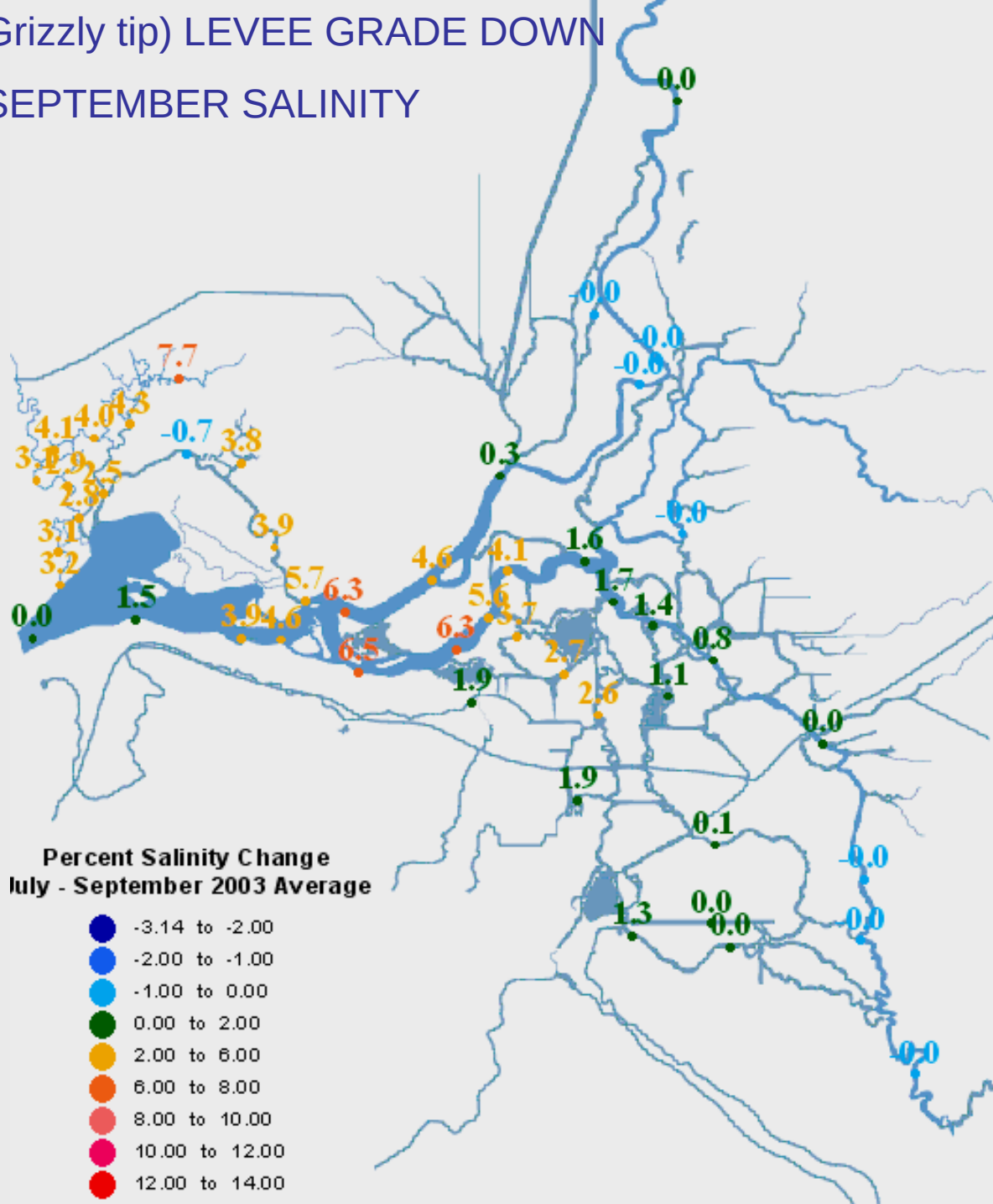
5. Writing group modeling review

IMPACT OF **COMBINED** (w/out Grizzly tip) LEVEE GRADE DOWN

PERCENT CHANGE IN JULY – SEPTEMBER SALINITY

WY2003 HYDROLOGY

DSM2 MODEL

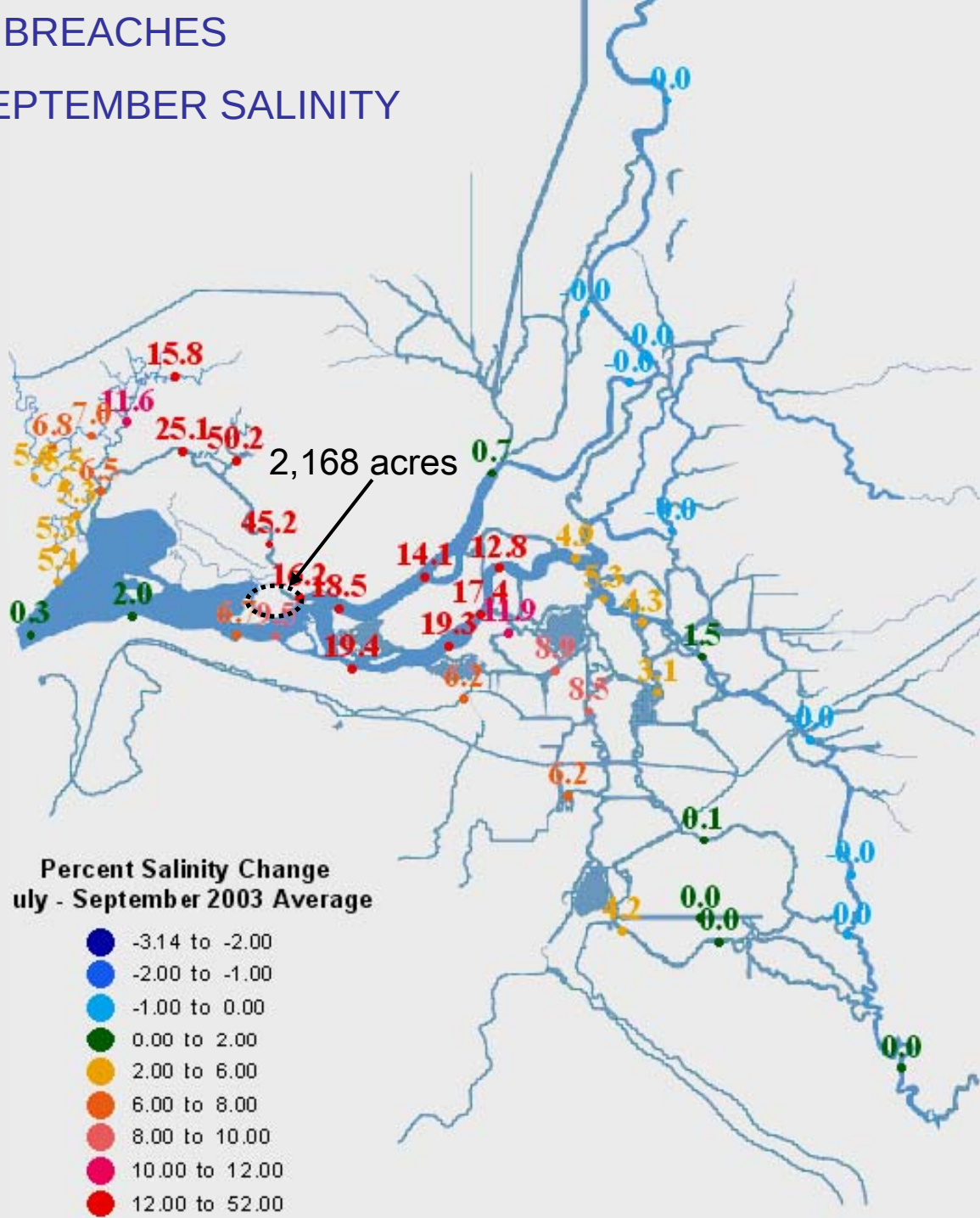


IMPACT OF **VAN SICKLE** LEVEE BREACHES

PERCENT CHANGE IN JULY – SEPTEMBER SALINITY

WY2003 HYDROLOGY

DSM2 MODEL



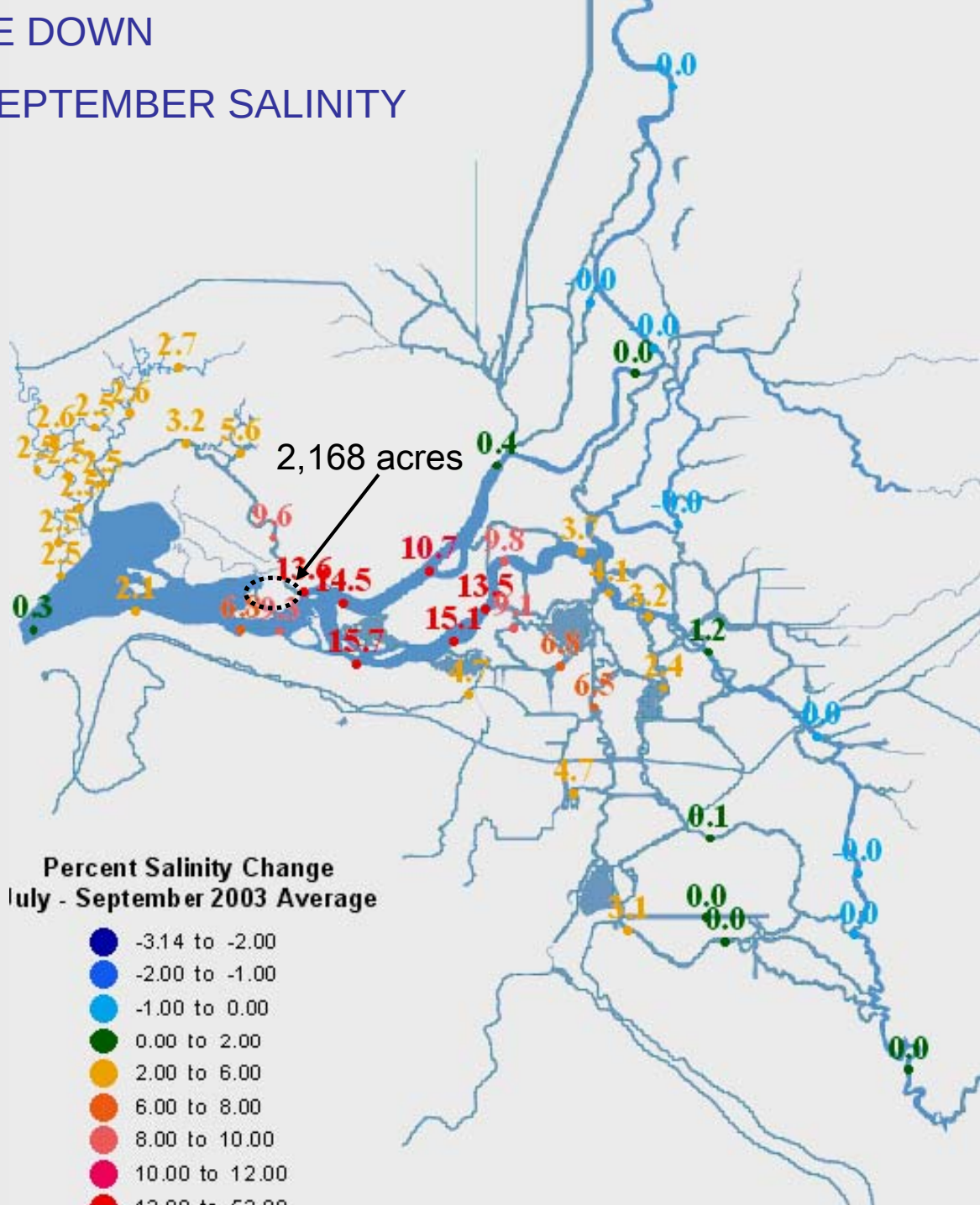
5. Writing group modeling review

IMPACT OF **VAN SICKLE** GRADE DOWN

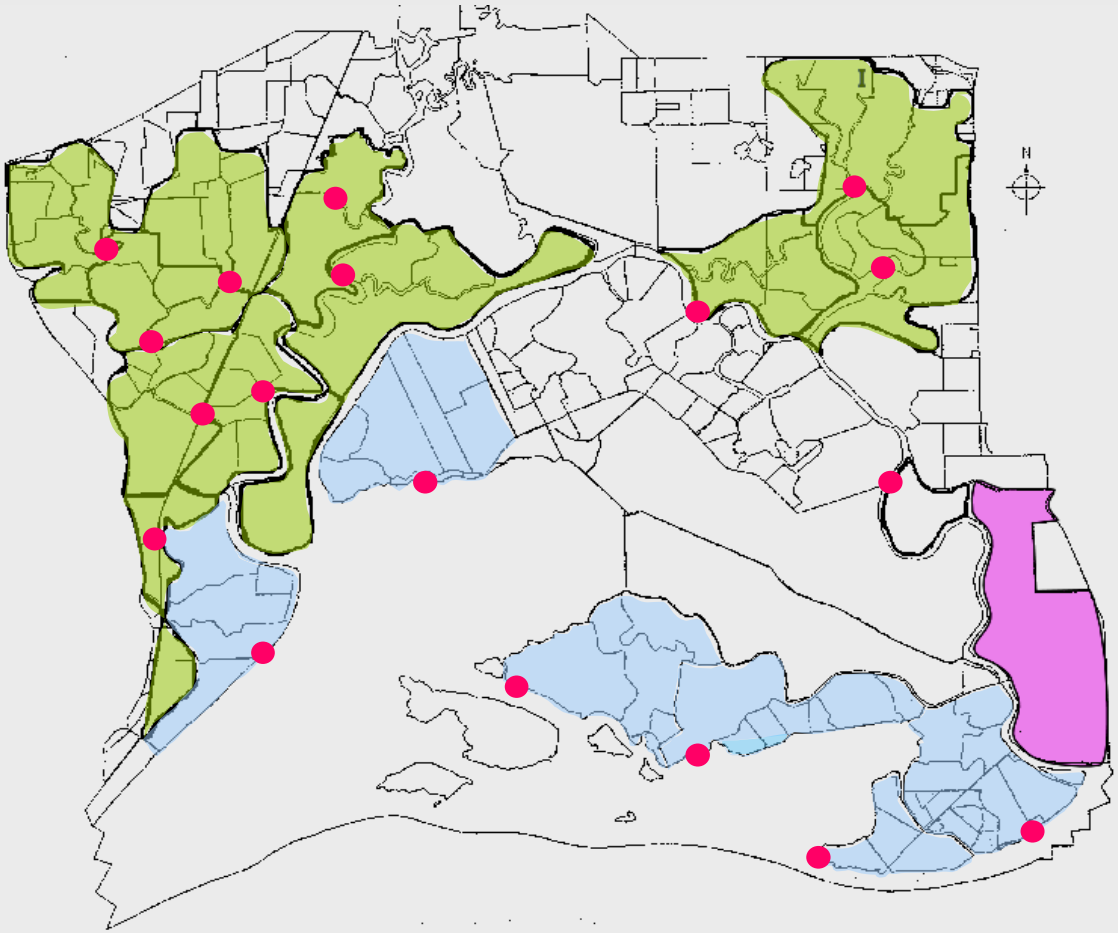
PERCENT CHANGE IN JULY – SEPTEMBER SALINITY

WY2003 HYDROLOGY

DSM2 MODEL



6. Summary of Salinity Modeling Results



Summary
Range of Percent Salinity Change* from Levee Breach Scenarios

Scenario	Western Marsh		Eastern Marsh		Delta	
	low	high	low	high	low	high
Morrow Island 100**	-1	+6	-6	-2	-6	-4
Morrow Island 5000	+5	+11	+3	+4	0	+5
Grizzly Island 100	-1	+6	-8	-6	-8	-5
Grizzly Island 5000	+6	+10	+5	+8	0	+3
Van Sickle Island 100	-17	-8	-15	+8	-9	+21
Van Sickle Island 5000	+1	+5	-6	+3	0	+6
Western Tidal Marsh option 100	+4	+16	-3	+6	-3	-8
Western Tidal Marsh option 5000	+2	+9	-5	-1	-3	-7
Northwest Tidal Marsh option 100	+2	+20	-9	-3	-5	-8
Northwest Tidal Marsh option 5000	+1	+10	-3	-1	-3	-1
Central Tidal Marsh option 100	+3	+18	-1	+9	-9	-6
Central Tidal Marsh option 5000	+3	+20	-7	+2	-10	-6
Northeast Tidal Marsh option 100	-2	+3	-24	+6	-8	-3
Northeast Tidal Marsh option 5000	-10	-1	-28	+22	-12	-5
Hill Slough West (levee grade down)	+1	+8	0	-2	0	0
Blacklock (levee grade down)	0	0	0	+4	0	0
Meins Landing (levee grade down)	+2	+7	-3	+3	0	+5
Grizzly Island (levee grade down)	+3	+4	-1	+7	0	+6

*numbers are percent change of salinity compared to base condition
** numbers are width of levee breach for each scenario

Thank you